ILLUMINATING ENGINEERING

DECEMBER 1951

Coefficients for Concentrating Luminaires
Characteristics of Plastics for Lighting
New Laboratory for Lighting Design Data
Lighting Techniques Modeled in Offices
General Secretary's Report 1950-1951
Luminous-Ceiling Dining Room
Lighting a Rifle Range

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

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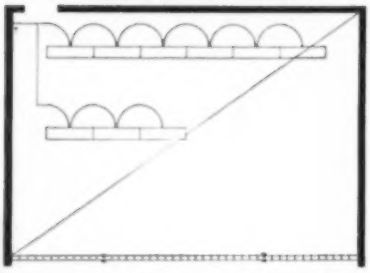
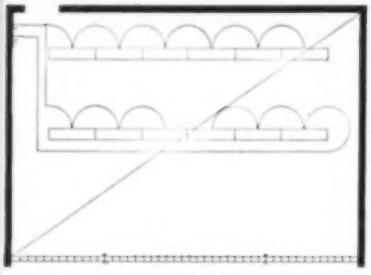
and still conserve critical materials

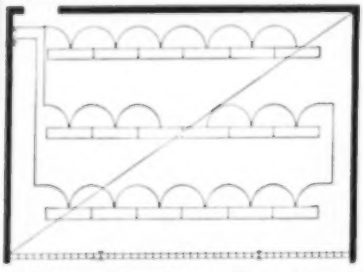
1 **Use Functional Lighting Layouts, Requiring Minimum of Luminaires.**



Save 1½ rows of luminaires—Minimum plan to supplement daylight. Utilizes 1½ rows of fixtures; corrects for body shadow cast by daylight from window-wall.



Saves 1 row of luminaires—Requires two rows of luminaires on the side away from window-wall. Supplementary light is completely adequate for daytime use.



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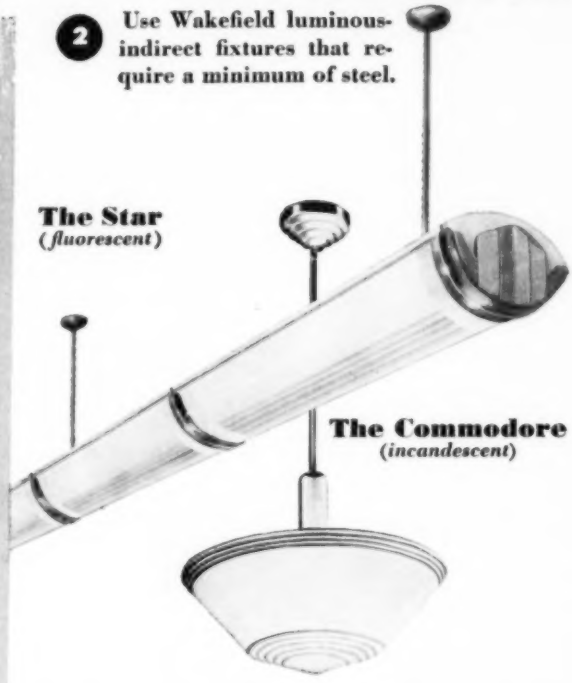

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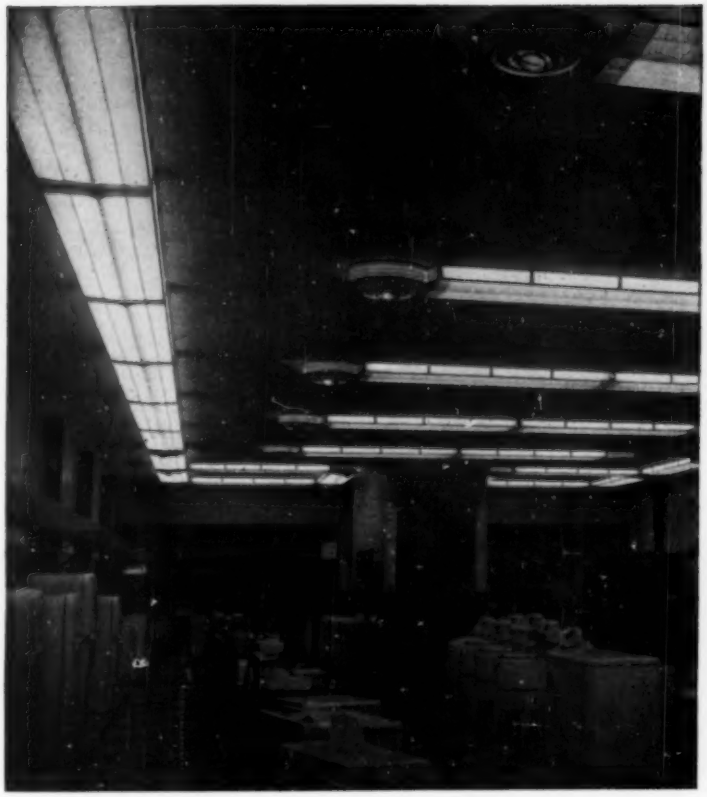

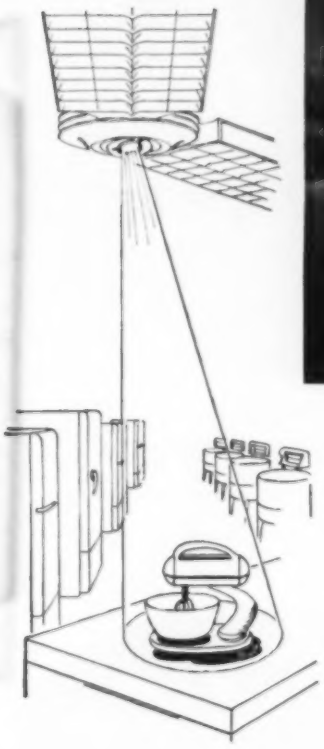

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DECEMBER
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PUBLICATION office 32d Street & Elm Avenue, Baltimore, Md.

EDITORIAL and advertising offices 1860 Broadway, New York 23, N. Y.

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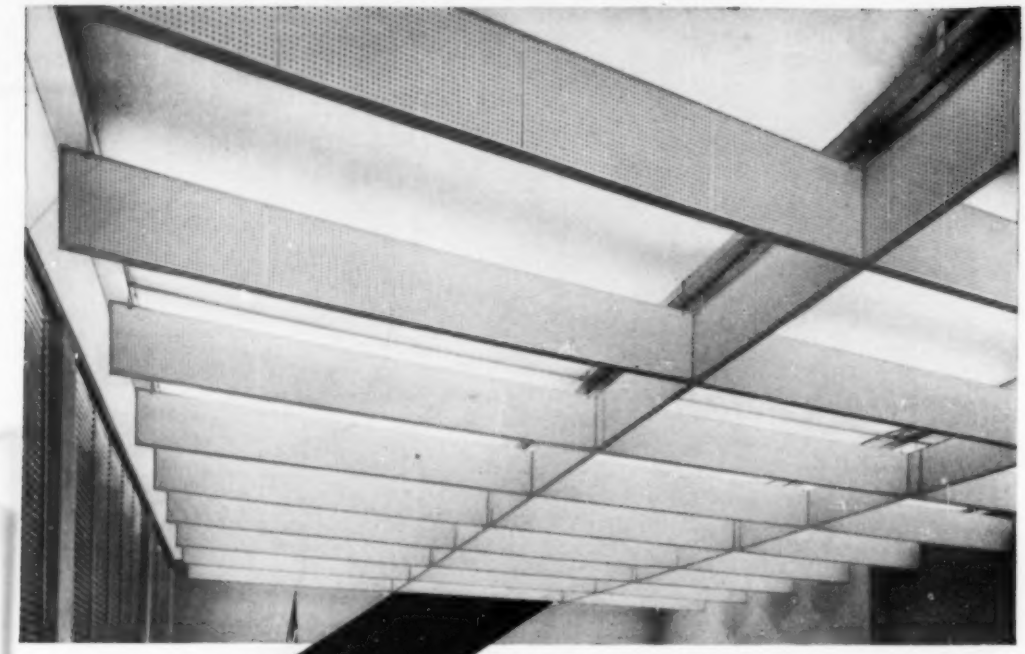

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Coefficients of Utilization for Luminaires with Concentrating Distributions

By J. R. JONES
JOHN J. NEIDHART

The currently used Lumen Method of calculating interior illumination was developed by Harrison and Anderson[1] during the period between 1915 and 1920. It is an empirical method based upon the results of experiments with typical luminaires of that time in rooms of various sizes and surface reflectances. Most luminaires of that day had rather broad downward distributions with less than half of the direct component flux in the 0-40° zone (flux ratio less than 50 per cent). Therefore, when new materials, processes, and design techniques made it possible to obtain more concentrating downward distributions, the method of calculating the coefficients of utilization used in the Lumen Method was no longer applicable for all luminaires. By extrapolation the basic data were extended to a 65 per cent flux ratio,[2] but this was far short of the requirements since some modern luminaires have flux ratios of over 90 per cent.

The need for additional accurate data has long been recognized[3] and other studies have been initiated to provide information that is applicable for all distributions. One of these has resulted in the Interflection Method,[4] which has been used as the basis for computing the data for the reflected components presented in this paper. The Interflection Method itself, however, was not carried to a conclusion so that it could be used directly to calculate coefficients of utilization. Also, the Interflection Method assumes that the working plane is located one-fourth of the distance from the floor to the ceiling. In the ordinary use of the Method this assumption will lead to considerable error in high bay lighting installations. However, the error can be largely eliminated by calculating separately the flux that strikes the working plane directly, as is done in this paper.

The real need is for a method of calculating coefficients of utilization that more fully recognizes differences in distribution of light flux from present day equipment. It would then be possible to provide more accurate coefficients of utilization for use in the familiar Lumen Method formulas.

Basic Method

To satisfy this need the authors are proposing a method of calculating coefficients of utilization that considers the ultimate disposition of the flux from every 10° zone instead of using an arbitrary wide zone of 40° as a criterion. The flux in each 10° zone (0°-10°, 10°-20°, etc.) that strikes the work plane directly is determined, and to that is added the flux that reaches the work plane by interreflection. The ratio of the total flux reaching the work plane to the lamp lumens is the coefficient of utilization.

Development of the Method

This method was developed by assuming specific symmetrical luminaire locations in a square room representing each room index. Then, for each luminaire location in a given room size, the percentage of the lumens in each of the 10° zones that strike the working plane directly was calculated (see Fig. 1 for approximate method of making calculation). By averaging the percentages for a given zone for all the luminaires, an average percentage

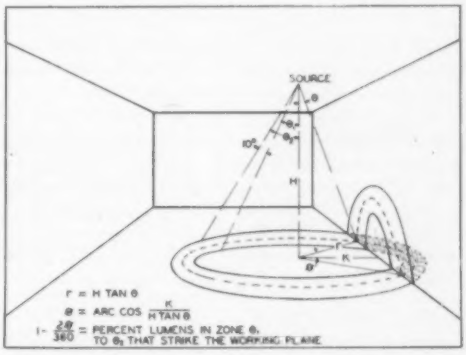

Figure 1. The flux in any zone that strikes the work plane directly is equal to the total lumens in the zone minus the lumens that strike the wall.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, August 27-30, 1951, Washington, D. C. Authors: Westinghouse Electric Corp., Bloomfield, N. J. and Cleveland, Ohio, respectively.

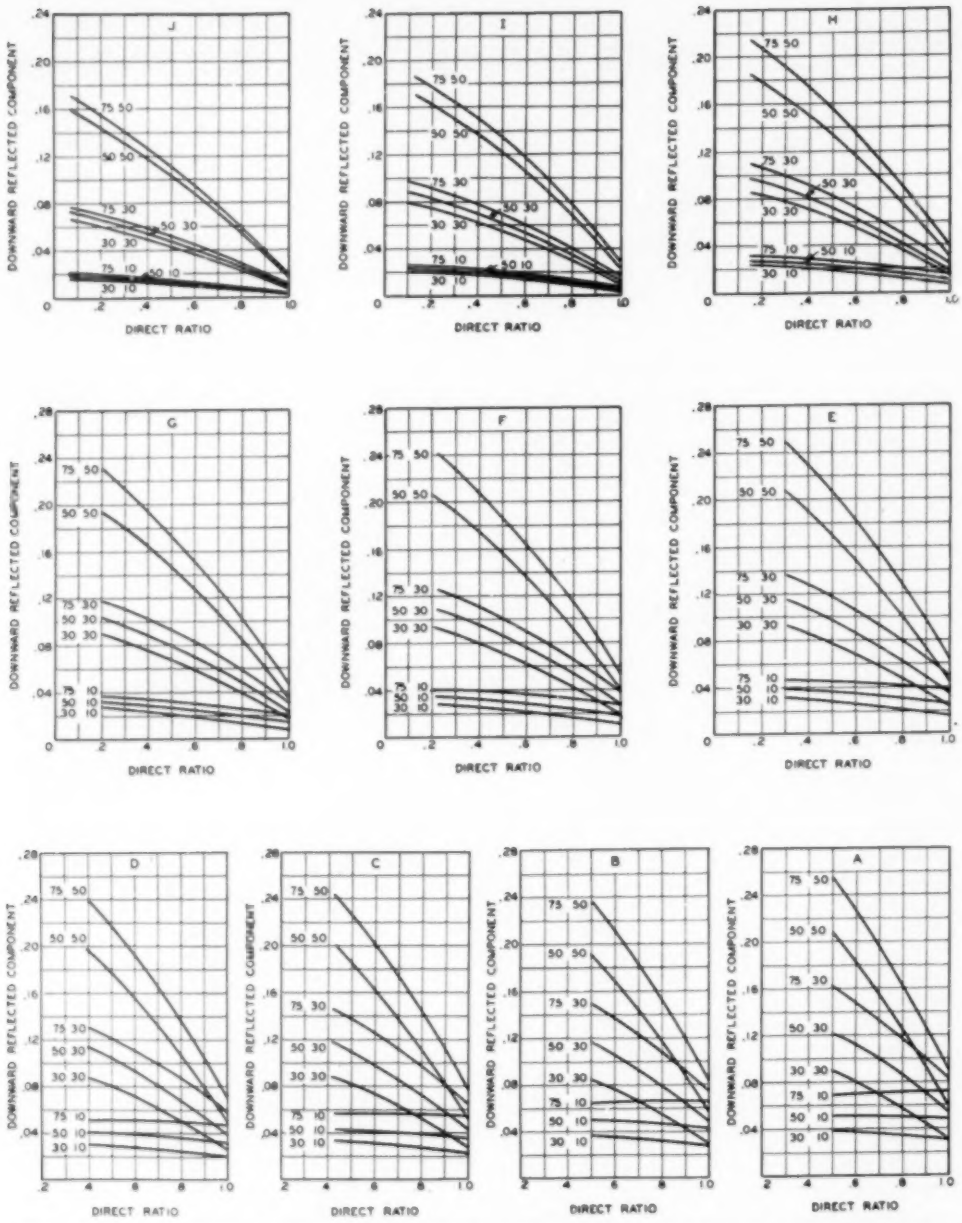

Figure 2. Downward reflected component plotted against direct ratio for each room index. The figures accompanying each curve denote the ceiling and wall reflectances.

for that zone was obtained. Such average figures, called zonal multipliers, have been prepared for each 10° zone for rooms of room index A through J, and are presented in Table I. They are in no

TABLE I.

Zone (Deg.)	Room Index J	I	H	G	F	E	D	C	B	A
	Zonal Multipliers 0° to 90°									
0-10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10-20	.72	.79	.81	.85	.88	.91	.92	.94	.95	.96
20-30	.57	.67	.73	.79	.83	.87	.89	.91	.93	.94
30-40	.34	.50	.56	.64	.69	.77	.82	.85	.88	.91
40-50	.16	.36	.49	.57	.64	.72	.78	.81	.86	.88
50-60	.03	.12	.28	.39	.48	.60	.67	.72	.78	.83
60-70	—	—	.05	.21	.31	.43	.52	.59	.69	.77
70-80	—	—	—	—	—	.11	.22	.32	.47	.60
80-90	—	—	—	—	—	—	—	—	.04	.14

way influenced by the distribution of the luminaire, but they are effective for all luminaires. To apply the method to a specific luminaire the luminaire lumens in each zone are multiplied by the appropriate zonal multiplier. The sum of these products for a specific room index, when divided by the total downward (0°-90°) lumens of the luminaire, is the percentage of downward lumens that strike the work plane directly. This quantity will be referred to as the *Direct Ratio*.

The percentage of downward luminaire lumens that are reflected from the room surfaces to the working plane (*Downward Reflected Component*) is directly related to the Direct Ratio in a given room. This relationship is illustrated in Fig. 2 where the Downward Reflected Component (obtained from interflection data) is plotted against the Direct Ratio for a wide range of distributions. A series of curves is given for each room index and combination of room surface reflectances. From these curves it is a simple matter to obtain the Downward Reflected Component for any Direct Ratio.

An indication of the accuracy of the method of calculation and calculating procedure (see Fig. 3) can be illustrated by assuming an area to be lighted is 48 feet square and 42½ feet high, and has 30 per cent ceiling and 10 per cent wall reflectances. Calculations were made for two widely different luminaire distributions by the conventional method, the zonal method proposed herein, and the point-by-point method. The point-by-point footcandle values cannot be converted to a coefficient of utilization or utilization factor because there is no indication of the magnitude of the flux reflected to the working plane. It can, however, be expressed as the direct ratio by merely multiplying by the area and dividing by the total luminaire lumens. In this manner a direct comparison can be made between the point-by-point method and the zonal

1000-WATT CONCENTRATING LUMINAIRE

ZONE	ZONAL LUMENS	ZONAL MULTIPLIER	PRODUCT
0°-10°	3005	1.00	3005
10°-20°	5580	.72	4020
20°-30°	3125	.57	1782
30°-40°	2310	.34	785
40°-50°	1180	.16	189
50°-60°	129	.03	4
60°-70°	40	—	—
70°-80°	—	—	—
80°-90°	—	—	—
TOTAL	15369		9785

DIRECT RATIO = $\frac{9785}{15369}$ = .635

C.U. = $\frac{15369}{21000^*}$ (.635 + .01) = .47

* LAMP LUMENS - 21000

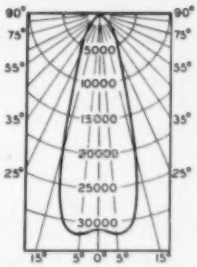

Figure 3. Calculation of the coefficient of utilization for a "J" room. The downward reflected component is .01 for 30% ceiling and 10% wall reflectances.

system proposed by the authors (see Table II). The point-by-point calculations were made for the points stipulated as measuring points in the I.E.S. Procedure for Determining Horizontal Footcandle Levels.[5]

An analysis of Table II indicates that in a high narrow room the Harrison-Anderson Method gives too low a value for direct concentrating luminaires and too high a value for direct luminaires having a rather broad distribution such as that of a typical industrial fluorescent unit. The zonal method data is actually based on nine luminaires in a "J" room so it checks closely with the point-by-point method.

Extending the Method to All Distributions

Although this method of calculating coefficients was developed primarily for direct luminaires, it soon became apparent that it was also applicable to distributions in which part or all of the light was directed upward.

For other than totally direct luminaires, the Direct Ratio and Downward Reflected Component are obtained as outlined in the preceding paragraphs, but their sum is multiplied by the ratio of the downward luminaire lumens to the total lamp lumens. This product is the *Downward Coefficient*.

To obtain a comparable *Upward Coefficient*, the percentage of upward (90°-180°) luminaire lumens that strike the ceiling (*Ceiling Ratio*) is obtained

TABLE II.

Method of Calculation	Concentrating Distribution: Utilization Factor	Concentrating Distribution: Direct Ratio	Wide Distribution: Utilization Factor	Wide Distribution: Direct Ratio
Harrison-Anderson	.51	—	.35	—
Zonal Method	.645	.635	.270	.255
Point-by-Point*	—	.645	—	.258
Point-by-Point**	—	.676	—	.270

*Assumes 9 sources are installed.
**Assumes 4 sources are installed.

by the use of zonal multipliers for each 10° zone by the same technique as was used to obtain the Direct Ratio (see Table III). This *Ceiling Ratio* is

TABLE III.

Zone (Deg.)	Room Index J	I	H	G	F	E	D	C	B	A
	Zonal Multipliers 90° to 180°									
90-100	—	—	—	—	—	.04	.14	.22	.33	.40
100-110	—	—	.10	.22	.32	.47	.60	.67	.76	.81
110-120	.20	.34	.43	.52	.59	.69	.77	.82	.89	.93
120-130	.37	.50	.60	.67	.72	.78	.83	.88	.91	.94
130-140	.56	.66	.72	.78	.81	.86	.88	.91	.94	.95
140-150	.63	.71	.77	.82	.85	.88	.91	.94	.96	.97
150-180	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

used only as the means of obtaining the *Upward Utilization Factor* from a series of curves in which Upward Utilization Factor is plotted against Ceiling Ratio (Fig. 4). Since the Upward Utilization Factor represents the percentage of upward *luminaire* lumens that is reflected to the working plane, it must be multiplied by the ratio of the upward luminaire lumens to the total lamp lumens to obtain the Upward Coefficient. (This would be the coefficient of utilization for a totally indirect luminaire.)

The sum of the Downward Coefficient and the Upward Coefficient is the Coefficient of Utilization for a luminaire that distributes the light both downward and upward.

Step-by-Step Procedure

The steps to be followed in computing the coefficient of utilization are:

(For totally direct luminaires, step 1 only; for totally indirect luminaires, step 2 only; for all others, steps 1, 2, and 3.)

1. Determine the Downward Coefficient as follows:
   a. Multiply the zonal lumens in each 10° zone from 0° to 90° by the respective zonal multiplier obtained from Table I.
   b. Add the results of step a.
   c. Divide the sum obtained in b. by the total luminaire lumens emitted downward. This is the Direct Ratio.
   d. From the appropriate curve of Fig. 2, determine the Downward Reflected Component for the Direct Ratio obtained in step c.
   e. Add the Direct Ratio and the Downward Reflected Component. This is the Downward Utilization Factor.
   f. Multiply the Downward Utilization Factor by the per cent of lamp lumens emitted downward by the luminaire. This is the Downward Coefficient. (If the luminaire is totally direct this is the coefficient of utilization.)
2. Determine the Upward Coefficient as follows:
   a. Multiply the zonal lumens in each 10° zone from 90° to 180° by the respective zonal multiplier obtained from Table III.
   b. Add the results of step a.
   c. Divide the sum obtained in step b. by the total luminaire lumens emitted upward. This is the Ceiling Ratio.
   d. From the appropriate curve of Fig. 4, determine the Upward Utilization Factor for the Ceiling Ratio obtained in step c.
   e. Multiply the Upward Utilization Factor by the per cent of lamp lumens emitted upward by the luminaire. This is the Upward Coefficient. (If the luminaire is totally indirect this is the coefficient of utilization.)
3. Add the Downward Coefficient (step 1. f.) and the Upward Coefficient (step 2. e.). This is the coefficient of utilization for a luminaire that is neither totally direct nor totally indirect.

Conclusions

While the method described herein does require a change in the method of calculating coefficients of utilization, the user of the Lumen Method *does not* have to change his method of making lighting calculations. The time required to calculate a complete set of coefficients of utilization by this zonal method is only slightly longer than by the conventional method. Certainly the greater accuracy obtained more than justifies the small amount of additional work which must be performed only once for each luminaire. Too frequently it is necessary for the lighting engineer, after carefully following all of the rules, to make excuses for inaccurate predictions. More accurate coefficients would explain the discrepancy on many occasions. Sometimes factors as improper voltage, non-typical lamps, inaccurate meter reading, and misjudged room surface reflectances result in errors, but often the coefficient of utilization is faulty.

While extensive, carefully controlled illumination tests have not yet been made to verify the coefficients obtained by this new method, the direct ratios have been spot-checked by the point-by-point method and have been found to be accurate. The authors feel this method can be used with confidence for calculating the coefficients for luminaires that direct the major part of their flux downward. To obtain comparable accuracy for the flux directed upward, the theoretical upward utilization factor curves shown in Fig. 4 should probably be lowered slightly (approximately 5 per cent) to compensate for light that is absorbed by the luminaire after being reflected off the ceiling (see last paragraph of the Appendix), even though some (perhaps complete) compensation is made in the determination of the Ceiling Ratio (see Appendix). This source of error is inherent in any system of calculating coefficients and the magnitude of the error depends on the characteristics of the luminaire and the number installed in a given area.

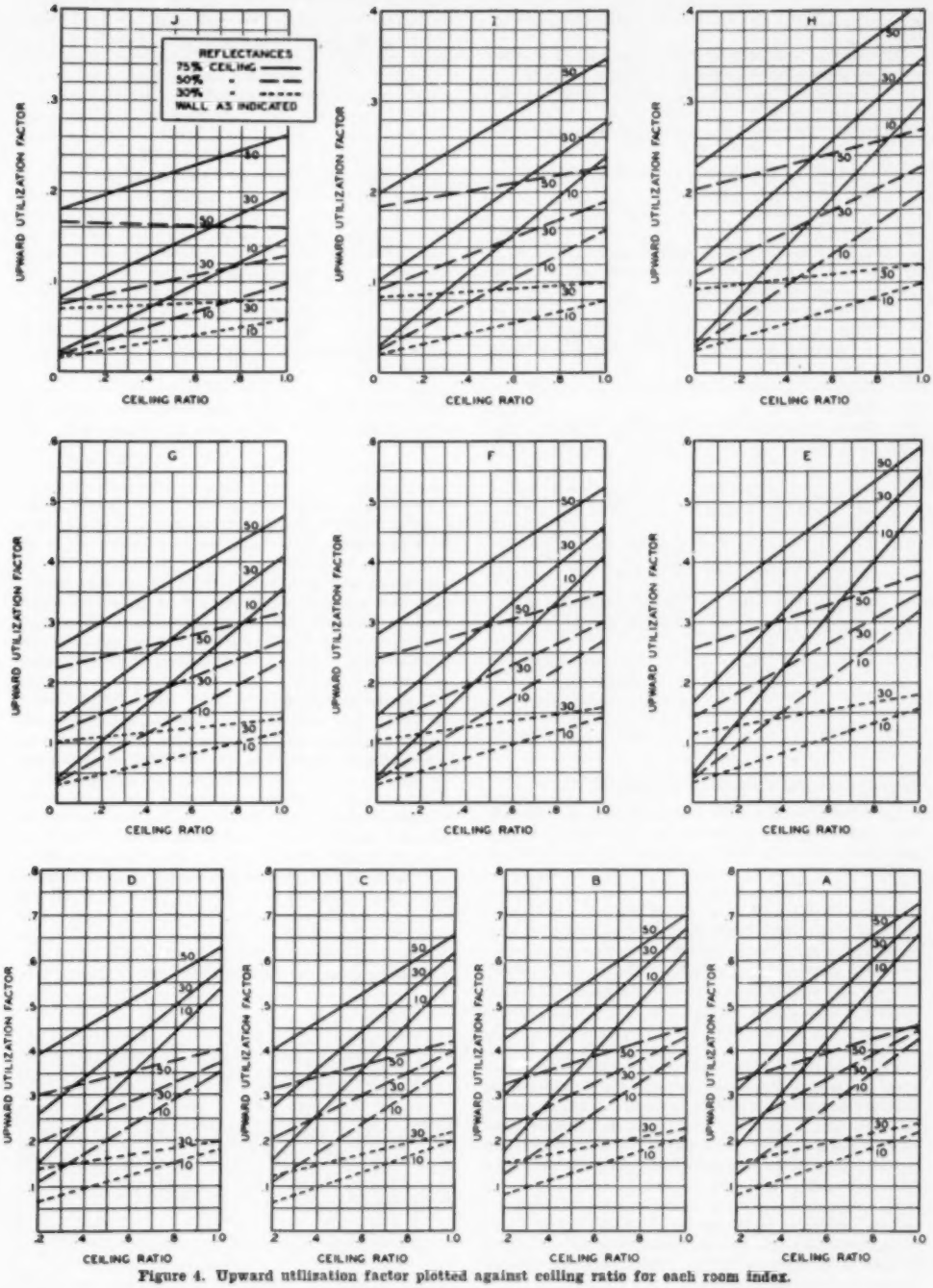

Figure 4. Upward utilization factor plotted against ceiling ratio for each room index.

Appendix

Terms and Symbols:

The following summary of terms and symbols is submitted for convenient reference.

F_D *Downward Flux*, luminaire lumens emitted downward (0° to 90°).

F_U *Upward Flux*, luminaire lumens emitted upward (90° to 180°).

F_L *Lamp Flux*, total lumens generated by the lamp or lamps in a single luminaire.

ZM *Zonal Multiplier*, for each 10° zone.

DR *Direct Ratio*, the per cent (expressed as a decimal) of the luminaire lumens emitted downward (0°-90°) that strike the working plane directly (without being reflected off room surfaces).

DRC *Downward Reflected Component*, the per cent of luminaire lumens emitted downward (0°-90°) that are reflected from the room surfaces to the working plane.

DUF *Downward Utilization Factor*, the sum of *DR* and *DRC*.

DC *Downward Coefficient*, the Downward Utilization Factor multiplied by the ratio of the Downward Flux to the Lamp Flux.

CR *Ceiling Ratio*, the per cent of luminaire lumens emitted upward that strike the ceiling (without reflections).

UUF *Upward Utilization Factor*, the per cent of luminaire lumens emitted upward that are reflected to the working plane.

UC *Upward Coefficient*, the Upward Utilization Factor multiplied by the ratio of Upward Flux to the Lamp Flux.

C.U. *Coefficient of Utilization* = *DC* for totally direct luminaires.
= *UC* for totally indirect luminaires.
= *DC* + *UC* for all others.

Derivation of the Method and Limitations:

The accuracy of this method of calculating coefficients of utilization obviously depends on the accuracy of the zonal multipliers and the reflected component curves of Fig. 2 and Fig. 4.

The zonal multipliers are calculated for specific symmetrical luminaire locations in a square room for each room index. For small high rooms the individual multipliers may be altered appreciably by basing calculations on different luminaire spacing-to-mounting-height ratios. The Direct Ratio is also somewhat dependent on the spacing-to-mounting-height ratio, being slightly lower when the luminaires are mounted closer together. For example, in the installations illustrated in Fig. 2 the actual coefficient of utilization, as calculated by the Point-by-Point Method, is about 5 per cent higher when four luminaires are used than when nine are employed. A spacing-to-mounting-height (above the work plane) ratio of .4 was used in calculating the zonal multipliers listed in Table I, so the Direct Ratios and the coefficients of utilization are always conservative, even for concentrating luminaires.

The zonal multiplier for a single zone for one luminaire may be determined by the method illustrated in Fig. 1. Or for greater accuracy, the term $2\phi/360$ may be ascertained by calculating the lumens that strike the wall and dividing by the zonal lumens as follows:

$$2\phi/360 = \frac{\text{Average Footcandles} \times \text{Area (shaded in Fig. 1)}}{\text{Zonal Lumens}}$$

$$= \frac{(I\ \text{Cos}^3\theta/H^2) \times \text{length of arc} \times dr}{I \times \text{zonal constant for } \theta_1 \text{ to } \theta_2}$$

$$\text{length of arc} = 2\phi r$$

$$= 2\phi H \tan\theta$$

$$r = H \tan\theta$$

$$dr = H \sec^2\theta d\theta$$

$$2\phi/360 = \int \frac{(I\ \text{Cos}^3\theta)/H^2 \times 2\phi\ H \tan\theta\ H \sec^2\theta d\theta}{I \times \text{Zonal Constant}}$$

$$= 1/\text{Zonal Const}) \int (\sin\theta \times 2\phi\, d\theta)$$

$$\phi = \text{arc cos}\ (K \text{ Cot } \theta/H)$$

$$\text{let } P = K/H$$

$$y = P \text{ Cot } \theta \qquad \text{then}$$

$$2\phi/360 = (1/\text{Zonal Const}) \int_{\theta_1}^{\theta_2} 2 \sin\theta \text{ arc Cos } (P \text{ Cot } \theta)\, d\theta$$

$$2\phi/360 = (1/\text{Zonal Const}) \left[2 \text{ Cos } \theta \times \text{arc Cos } y + \text{arc sin} \left(\frac{2y^2 + P^2 - 1}{1 + P^2} \right) \right]_{\theta_1}^{\theta_2}$$

The above quantity checks closely with the value for $2\phi/360$ determined by Fig. 1. The solution of this formula for all the zones for each luminaire location and for all room indices is obviously a long and tedious task. Hence, this formula was used only for the relatively high narrow rooms and a few of the others. The zonal multipliers for most of the larger rooms were calculated by the method illustrated in Fig. 1. The authors feel that the resultant errors are negligible because of the large number of sources involved.

If the zonal multipliers in Table I are plotted against room index (the ratio of the room width to two times the mounting height above the work plane), curves will be obtained (Fig. 5) from which it is convenient to select zonal multipliers for calculating the flux that the luminaires direct to the floor. These zonal multipliers for the floor were determined on the basis of the room index formula, but the mounting height above the work plane was changed to mounting height above the floor. These zonal multipliers (for the floor) were then used to calculate the flux directed to the floor (designated F_2 in the Interflection Method data) for certain luminaires. Obviously the remainder of the 0° to 90° flux (F_1) was directed to the walls. Knowing F_1 and F_2 for specific luminaire distributions, it was then possible by using the Interflection Method to calculate the

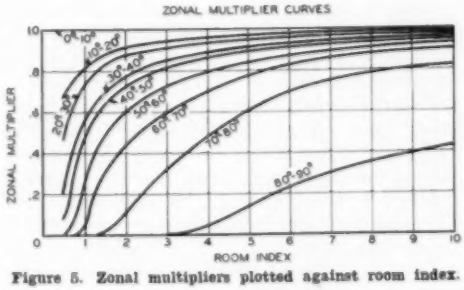

Figure 5. Zonal multipliers plotted against room index.

curves of Fig. 2 where the sums of the wall and floor components are plotted against the Direct Ratio for a wide range of distributions. An assumed floor reflectance of 14 per cent was used in order to correspond with that of the Harrison-Anderson Method.

Fig. 5 was also used to determine the zonal multipliers for calculating the Ceiling Ratio. It is obvious that this is possible if the ceiling is thought of as the work plane and the length of the suspension hanger is thought of as the mounting height of a direct luminaire above the working plane. The "room index" of this space between the luminaire and the ceiling was calculated from the room index formula for direct luminaires. For this calculation the length of the suspension hanger used as "mounting height above the work plane" was such that the same room index (for the entire room) would be obtained from the room index formula for indirect luminaires as would be obtained from the room index formula for direct luminaires. To obtain the same room index from both formulas, the length of the suspension hanger must always be one-half the distance the luminaire is mounted above the work plane. Hence, the "room index" of this upper area is always twice that of the room below as calculated for a direct luminaire. Therefore, the ceiling zonal multipliers for an "I" Room (room index = 1.0), for example, are found in Fig. 5 at room index equal 2.0. The 90° to 100° multiplier is on the curve marked 80°-90°, the multiplier for the 100° to 110° zone is on the curve marked 70°-80°, etc. In actual practice the length of the suspension hanger is usually less than one-half the mounting height above the work plane so the actual ceiling ratios are somewhat higher than those obtained from Table III. This tends to make the upward coefficients slightly conservative. Also, Table III is really based on a spacing-to-mounting-height ratio of 0.8. This too tends to produce results that are slightly conservative. On the other hand, the multipliers for the 150° to 180° zone have been raised to 1.0, making the zonal multipliers somewhat less conservative but more realistic. They are more realistic because almost invariably indirect luminaires are hung near enough to the ceiling for all the lumens in this zone to strike the ceiling directly.

The ceiling zonal multipliers (Table III) and the Interflection Method were used to prepare Fig. 4 just as Table I and the Interflection Method were used to prepare Fig. 2.

The reflected component curves (Fig. 2 and Fig. 4) reflect the accuracy of the interflection data on which they are based and they are subject to the same limitations. Data for the curves representing 30 per cent ceiling reflectances were extrapolated, and the data for the other curves were interpolated. The interflection data are based on the assumption of perfectly diffusing room surfaces that are illuminated uniformly. Actually the maximum wall brightness created by a luminaire is near the ceiling for wide distributions, and approaches the floor as the distribution becomes more concentrating. Also, the room surfaces are never perfectly diffusing, but it is felt that these variables introduce only small errors into the reflected component curves.

The Upward Coefficients are based on the assumption that the luminaires are very small and do not absorb any light that is reflected off the ceiling. Actually all luminaires absorb some light and some fluorescent types that are rather large may absorb a sufficient amount to lower the Upward Coefficient enough to justify changes in Fig. 4. This error is of the same general nature as that caused by the existence of furniture, machinery, or columns in an area. The authors feel that until this source of error is investigated, the Upward Utilization Factor curves of Fig. 4 should probably be lowered about 5 per cent.

References

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4. Moon, P., and Spencer, D. E.: "Lighting Design," Addison-Wesley Press, Cambridge, Mass. (1948). Report No. 3 of the Committee on Standards for Quality and Quantity of Interior Illumination. "The Interreflection Method of Predetermining Brightness and Brightness Ratios," *Transactions of the Illuminating Engineering Society*, Vol. XLI, No. 5, p. 361 (May 1946).
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DISCUSSION

NEAL JACOBUS*: This paper suggests a new method of determining coefficients of utilization which will provide more accurate values than the presently used method. The need for more accurate coefficients is generally recognized specially where light interior surfaces and luminaires with strong indirect components are used. The authors are to be congratulated for undertaking this work.

Of particular importance is that the method can be applied to data from candlepower distribution curves commonly available for luminaires. The basic interflection method required photometric data generally not available. Greater emphasis relative to the reflectivity of the floor (14 per cent) would seem desirable. Data for at least one higher value of floor reflectivity would be useful and interesting. A paragraph relative to the basis of determining the "room index" is suggested. This would help correlate Tables I and III and Figure 5 and also remove any question as to on what basis the RI was determined. While the working plane is referred to in several places, it is not unmistakably clear as to just what height above the floor was used. Relative to the method being dependent upon symmetrical luminaire locations, this does not seem to be a serious objection considering the lumen method applies only when the distribution of light on the working plane is reasonably even.

Lighting engineers responsible for calculating and publishing coefficients of utilization for luminaires would do well to study this paper. It is hoped they would determine coefficients for several typical luminaires and compare them with those determined by the conventional method. The authors would certainly welcome comments and reports of field experience.

J. A. LOSH**: The authors of this paper have assumed the difficult task of reconciling the units of the lumen and interflectance methods. The extent of their success can probably be best realized by experiment.

If the authors had investigated the basic interflectance method equations further they would have seen that the two statements, "The Interflection Method itself, however, was not carried to a conclusion so that it could be used directly to calculate coefficients of utilization" and "Also, the Interflection Method assumes that the working plane is located

*Sylvania Electric Products, Inc., Buffalo, N. Y.
**Smithcraft Lighting Div., A. L. Smith Iron Co., Chelsea, Mass.

one-quarter of the distance from the floor to the ceiling" are not true.

Interflectance is another name for what is called "utilization factor." That is, the coefficient of utilization is equal to the product of efficiency and interflectance or utilization factor or any other name by which the entity of surface reflectance, room shape and flux distribution is known. The very name of the method implies that it is a means whereby coefficients of utilization can be known.

The Interflectance Method equations can be used to calculate the interflectance on any plane, including the 30" plane, for any ceiling height. It is the Q&Q committee, not the method, that assumes the one-quarter figure above.

H. L. LOGAN*: This is the kind of material that goes far in filling the voids that exist in the present day lighting art. The method proposed can be expected to attain rapid and widespread use by engineers. The paper satisfies a real need.

Some important limiting conditions should be clearly stated. The coefficients of utilization obtained for certain specific luminaire locations at certain specific spacing-to-mounting height ratios in square rooms will not always hold true in general application. The engineer must consider whether the problem at hand is within the limits of this method—whether the coefficients of utilization will apply to the given interior.

For example, if the luminaire layout is symmetrical but not the standard layout which calls for the end rows of luminaires to be a distance from the walls equal to half the spacing betwen rows (assumed to be the layout used by the authors) or if the luminaire layout is non-symmetrical which is the case in a high percentage of the jobs (industrial) which require luminaires with concentrating distributions, then the zonal multipliers will vary, perhaps considerably, from those arrived at in Table I by the authors. The coefficients of utilization calculated by this method will be most accurate for standard symmetrical luminaire layouts.

In small rooms particular caution should be used in application if the spacing-to-mounting height ratio differs appreciably from the .4 used by the authors in calculating the zonal multipliers.

Finally, the authors' proposal is still frozen to one floor condition, namely 14 per cent reflection factor, just as was the original Harrison-Anderson Flux Method. That this can make an important difference in interiors such as gymnasiums, sports arenas, airplane hangars and similar spaces is indicated by one example where the Jones-Neidhart coefficient of utilization would be 54.6 but the actual coefficient based on a 30 per cent floor, would be 60.6 per cent. It is to be hoped that the authors will add one or more floor reflectances to their tables, in addition to the one they are using of 14 per cent. In fact, 14 per cent has no particular validity. A series of 10, 20, and 30 per cent would be more useful.

W. M. POTTER**: All concerned with the design of lighting installations will appreciate the considerable efforts of the authors to extend the range of over-all utilization data. Such analyses—of a problem whose complexity is evident from their charts for only one floor reflectance and only one spacing ratio—contribute much to needed information. As the authors point out, however, the reflected components for direct lighting and all the results for indirect are based on other calculations involving assumptions that may cause departures in varying degree from the results in actual practice. These need experimental evaluation over a wide range of conditions. I would further comment that the method appears most readily employed for individual small luminaires with candlepower distributions symmetrical about a vertical axis.

Over-all utilization data appears to be most useful if based on a certain degree of uniformity of illumination. In this paper the computations for all downward zones are based on a fixed small spacing-to-mounting height ratio, which, although it yields conservative coefficients, may not equitably reflect the situation for units of wide distribution.

This spacing ratio selected by the authors is 0.4. We have compared (a) actual test results for direct lighting elements at this ratio in room conditions of J and H index with (b) calculations using the Jones and Neidhart zonal factors as applied to the candlepower distributions used in our tests. In the calculations appropriate corrections were made for the differences in room reflectance conditions. Test results were 8 per cent and 4.7 per cent higher than the calculated results.

In the authors' calculations on indirect lighting, a ratio of spacing-to-suspension distances of only 0.8 is used as a basis. This would mean, for example, only 24" luminaire spacing for a 30" suspension, or a very long suspension for normal spacing—conditions which are certainly not at all representative. A different ratio would affect the number of luminaires and their relationship to wall and ceiling surfaces, and the distribution of ceiling brightness. At first glance, indirect lighting appears simple. But tests of even limited scope reveal that differences in utilization resulting from changes in luminaire location and suspension distance cannot be ignored.

The usefulness of utilization data by 10-degree or even smaller zones is recognized. However, I feel that a single figure or flux ratio may still be useful for ready description of candlepower curves. It may be different from the one selected by Harrison and Anderson. They selected the ratio of 0-40 degree lumens to 0-90 degree lumens as applying to common types of curves, specifically excluding those with the flux concentrated in very narrow zones.

J. R. JONES and J. J. NEIDHART*: The authors appreciate the comments that Mr. Jacobus, Mr. Losh, Mr. Logan, and Mr. Potter have offered.

Mr. Jacobus and Mr. Logan have both suggested that data be made available for higher reflectance floors. The curves in Figures 2 and 4 are now based on a 14 per cent floor reflectance in order to agree with the presently published coefficients of utilization. The authors agree, however, that additional curves of the same general form as Figures 2 and 4 should be provided for higher reflectance floors. Tables I and III would not be altered since they are used only to determine the per cent of luminaire lumens that strike, directly, the work plane and ceiling respectively. These ratios are not affected by room surface reflectances.

Tables I and III, as Mr. Logan and Mr. Potter point out, assume a 0.4 spacing-to-mounting height ratio. This is a lower ratio than most luminaires require in order to attain uniform illumination on the work plane. Thus, the Direct Ratios and Ceiling Ratios are conservative (particularly in high narrow rooms) for luminaires that are likely to be

*Holophane Company, Inc., New York, N. Y.
**General Electric Co., Cleveland, Ohio.

*Authors.

spaced further apart in actual installations. The reader should bear in mind, however, that in order to provide an adequate quantity of illumination, luminaires are frequently spaced closer together than is necessary to provide *uniform* illumination. This practice is particularly prevalent in installations employing one- and two-lamp fluorescent luminaires. Also, in high narrow rooms the coefficient of utilization is low so luminaires must be spaced close together to provide an adequate level of illumination, and being in a high narrow room they would likely be mounted rather high so the spacing-to-mounting height ratio is quite low, particularly for high illumination levels. So the error *tends* to be minimized, but the coefficients are no doubt generally slightly conservative.

The data in Tables I and III are calculated specifically for square rooms, as Mr. Logan points out. However, it is but a simple matter to determine the room index of an equivalent rectangular room by the use of the two standard I.E.S. room index formulas[1] which the authors used, or by the standard room index table. The height of the working plane above the floor was assumed to be 30 inches although this dimension cancels out in these two equations. The data in Table I were calculated using the I.E.S. formula for predominantly direct luminaires, and Table III was calculated using the I.E.S. formula for predominantly indirect luminaires. The standard conversion table was used to convert from Room Ratio to Room Index.[2] The authors feel that basing the data on square rooms introduces no problem and concur with Mr. Jacobus' comment that dependence of the method on a symmetrical luminaire layout does not present any serious objection. Any system of calculating illumination levels that is based on the concept of a coefficient of utilization would necessarily be subject to the same kind of limitations (i.e. uniform illumination, approximately symmetrical spacing, etc.). A coefficient of utilization cannot possibly be exactly correct for all layouts. As Mr. Jacobus points out, the Lumen Method applies only when the distribution of light on the working plane is reasonably uniform.

It is interesting to note that most of Mr. Potter's objections to the authors' Zonal Method are also applicable to the existing method of calculating coefficients. If the simplicity of the Lumen Method of calculating illumination is to be retained, certain assumptions must be made that will not always agree with actual installation conditions. Despite these necessary limitations, it cannot be denied that the proposed Zonal Method is more accurate than the currently used method. The authors admit conservatism and consider Mr. Potter's test results as verifying the accuracy of the method.

Although a 0.8 spacing-to-suspension distance ratio may seem unrealistic for indirect lighting, it would be inconsistent to select any other ratio as a basis for Table III if the 0.4 ratio is selected for Table I. To satisfy both the standard I.E.S. formulas for room index (one for predominantly direct luminaires, the other for predominantly indirect luminaires), it is necessary for the luminaire to be suspended one-half as far below the ceiling as it is above the work plane. Thus, if the spacing-to-mounting height (above work plane) ratio of 0.4 is selected, the ratio of luminaire spacing-to-suspension distance must be 0.8. The authors agree with Mr. Potter that this 0.8 ratio should be nearer 3.0, but if the 3.0 ratio had been used one would obtain a different coefficient of utilization for a totally indirect luminaire than one would obtain from the indirect component of a direct-indirect luminaire. Therefore, the authors feel that until the room index formulas are altered, it is imperative that the 2.0 to 1.0 (0.8 to 0.4) ratio be maintained. Perhaps the room index formulas should be re-examined. Even with the 0.8 ratio, however, the results of a few tests on indirect installations indicate slightly conservative but considerably more accurate coefficients by the zonal method than the current method. In the light of Mr. Potter's objections to the limiting assumptions that the authors had to make to retain simplicity, it seems incongruent to suggest the use of a single figure or flux ratio as being sufficiently descriptive of a luminaire distribution.

Mr. Losh is correct in stating that it is difficult to reconcile completely the Lumen Method and the Interflectance Method. However, aside from the difference in the method of classifying the room shape there is no significant difference between the two methods. In both methods the initial illumination level is equal to the quotient of the product of lamp lumens, utilization factor (or interflectance) and luminaire efficiency (or logance) divided by room area. So the two methods are not dissimilar.

Mr. Losh has taken exception to two statements that appear in the paper. The authors believe that there is no real disagreement, but actually only a difference in opinion as to what should be the definition of "Interflectance Method." The authors consider that the Reports of the Committee on Standards of Quality and Quantity have described the Interflectance Method.

The authors were aware that the basic equations can be used to calculate interflectance tables for the 30-inch work plane or any work plane. So far, however, tables have been prepared only for a work plane located one-fourth the distance from the floor to the ceiling. It is not convenient for the lighting application engineer, or for anyone, to use the basic equations to calculate interflectances for the 30-inch work plane for typical luminaires. So until tables are prepared for the 30-inch work plane the ordinary use of the Interflectance Method will lead to considerable error in high bay lighting installations.

Mr. Losh also states that the basic equations can be used to calculate coefficients of utilization. For luminaires that have a distribution approximately the cosine curve, or some other simple mathematical function, this is true. But for other luminaires it is necessary to measure or calculate the percentage of luminaire lumens that strike the walls, ceiling, and floor. To calculate these percentages with the basic interflectance equations would be a difficult task. The authors are not aware that anyone has made such calculations for luminaires that are not perfectly diffusing. It is assumed that Mr. Losh is referring to a system[3] wherein the per cent flux striking the walls, ceiling, and floor was determined by measurement in order to obtain these percentages for use in conjunction with the tables published in Report No. 3 of the Committee on Standards of Quality and Quantity.

The authors do not consider the system mentioned above,[3] nor the basic equations used to develop the interflection method, any more a part of that method than the test room of Harrison and Anderson was a part of their method. They were all tools that were used in the development of the two methods.

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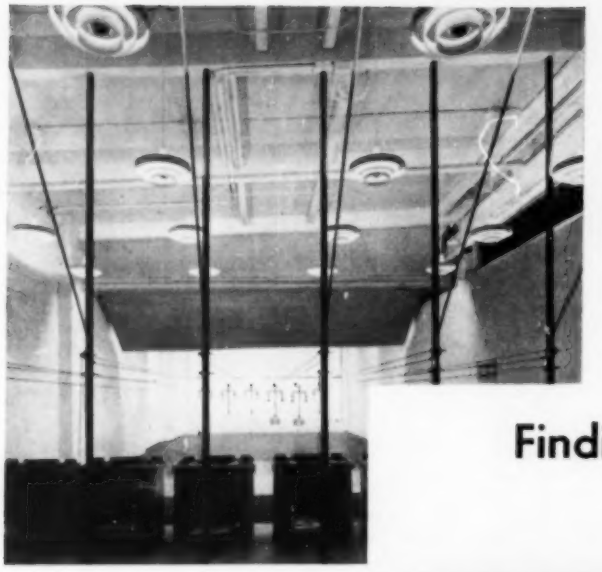
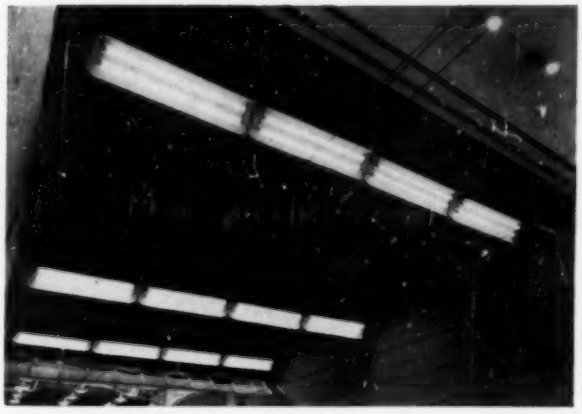
2. *IES Lighting Handbook*, Second Edition, p. 9-5.
3. Coradeschi, R. A., and Innis, L. E.: An Application of the Interflection Theory to Commercial Practice, ILLUMINATING ENGINEERING, Vol. 43, 1948, p. 949.



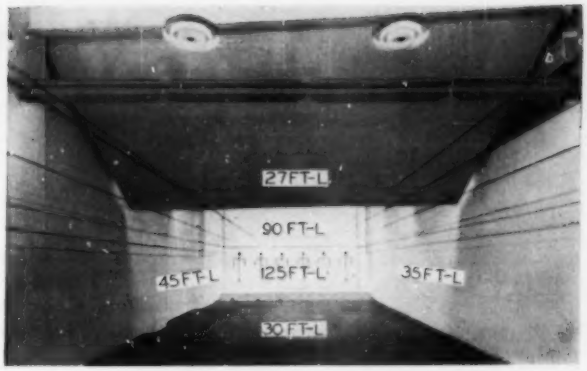
ON THE FIRING LINE, sixteen concentric-ring silver-bowl units provide approximately 40 footcandles illumination. These 500-watt luminaires were chosen to eliminate gun-sight shadows and disturbing image reflections on the barrel of the gun.

Finding Your Range



ALONG THE RANGE, four rows of 2-lamp 100-watt industrial fluorescent luminaires, tilted approximately 45 degrees toward the targets, are mounted three rows on the target side of the baffle and one on the far side. Illumination levels average 60 footcandles.

ON THE TARGETS the 130-footcandle level is provided by two rows of seven 300-watt R-40 floodlights, one row on the floor and one ceiling-mounted. Both rows are installed five feet out from the targets on 3½-foot centers.



BRIGHTNESS RATIOS along the range are improved by the use of light surfaces for ceiling, walls, floor and background for targets. Ratio between background and walls is 3:1, between background and floor 4:1 with 130 footcandles illumination on the background.

In the Right Light

GRATIFIED members of the Detroit Edison Rifle Club without exception improved their averages after the rifle range had been relighted. To satisfy the critical seeing tasks, involved, five requirements were considered necessary for good seeing conditions: (1) adequate levels of illumination, (2) freedom from direct glare, (3) freedom from reflected glare, (4) good brightness ratios and (5) absence of harsh shadows.

A combined system of incandescent and fluorescent lighting was chosen. Illumination on the firing line is provided by sixteen 500-watt concentric-ring silver-bowl units, spaced on 6 x 6½-foot centers, suspended three feet from the fifteen-foot high ceiling. These luminaires were chosen to eliminate gun-sight shadows and image reflections along the barrel of a gun.

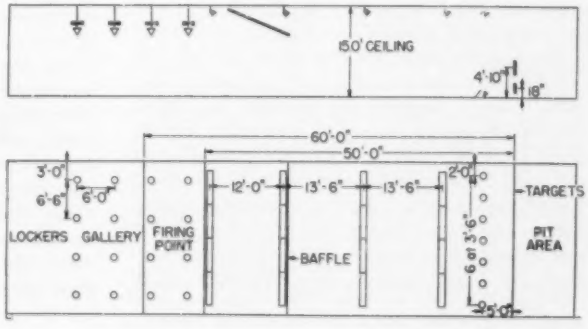
Along the range, four rows of 2-lamp 100-watt industrial fluorescent fixtures were installed, tilted approximately 45 degrees toward the target. One row is on the near side of the baffle and three on the target side to obtain good distribution of illumination levels.

A row of seven 300-watt R-40 floodlights is mounted on both the ceiling and floor, five feet out from the targets, on 3½-foot centers. Illumination level on the targets averages 130 footcandles. On the firing line the level is 40 footcandles and along the range it is 60.

A light color scheme was followed for all surfaces, including the floor. Background for the targets is made of 3 x 8-foot wallboard, tinted the same color as the target paper. The wallboard is replaced periodically.

Brightness ratios are 3:1 between the background and walls and 4:1 between background and floor. Walls and ceiling are acoustically treated.

Photographs and data submitted by R. G. Watkins of the Detroit Edison Company, Detroit, and member of the Michigan Section, I.E.S.



PLAN VIEW AND ELEVATION show location and spacing of the incandescent and fluorescent luminaires on the rifle range. The fifteen-foot high ceiling is acoustically treated as are the walls at firing line and along the range.

Lighting Techniques Modeled In Utility Branch Offices

By J. D. WHITNELL
T. L. BUCKLEY

Five separate branch offices of the Central Arizona Light and Power Company serve as examples of various methods of achieving good lighting. Different layout and types of lighting design, and different window display techniques for each branch constitute demonstration areas for clients to study.

THE Central Arizona Light and Power Company in Phoenix, Arizona has recently completed five separate branch offices, each featuring various methods and techniques for offices, stores and show windows. Early in 1950, the company started a program to replace its central downtown business office with five neighborhood offices in strategic areas in and around the city of Phoenix. Each office was planned to be a typical example of good lighting, with adequate provision for display and window lighting; each branch to have a different layout and type of luminaire, and each window designed to show a different method of window illumination. Since completion of these "lighting education centers" in August 1951, local merchants and others having lighting problems may be taken to the several branches to see examples of lighting techniques from which they may choose the type which would best solve their particular lighting problem. In addition, of course, the offices perform the regular functions of a utility office—payment of bills, opening of new accounts, consultation service, and display of merchandise.

All installations were designed to give a high level of illumination with a minimum of glare. Luminaires were spaced so that variation in illumination at thirty inches above the floor would not exceed more than five footcandles. Preliminary plans were made for 75 footcandles maintained, and final planning resulted in values from 65 to 85 footcandles in the various offices. A check made some sixty days after the installations had been completed showed actual results in the five offices in accordance with final design plans.

Paints, woodwork finishes and furniture finishes were chosen to augment the lighting. All ceiling reflectances except one are 75 per cent or higher; the one exception has a ceiling the same color as the walls for decorative purposes. Here a direct type of luminaire was used with excellent results, although the reflectance of the ceiling is somewhat less than the best practice dictates. All wall surfaces are a light green with a reflectance of 56 per cent. Floors average 20 per cent but this will be increased as soon as the floor covering is installed. Furniture and all desk tops are light gray in color.

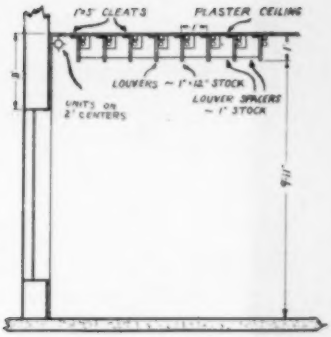
In addition to the display of all kinds of electrical equipment, it was planned that merchandise such as jewelry, clothing, furniture etc., could be placed in the "model" windows, so that the merchandisers of these products could determine by actual trial what type of lighting would make the particular items appear to their best advantage. Fixture salesmen, electrical contractors, builders and display men are invited to use these facilities in any way they wish, to demonstrate good window illumination to their customers.

With these offices and window installations, lighting engineers can actually demonstrate many of the solutions to lighting problems which are common in the commercial and office fields. Comparison of recessed, surface mounted, and suspended units is readily shown. Two types of louvered ceilings using cubical cells and a custom built louvered ceiling can be shown at full scale. Lamp colors, spot and floodlighting effects, and combinations of light sources depend only on the throw of a switch.

The display window at one office, for instance, lent itself as a test station not long ago when plans were being made to light meter panels in a control room. After preliminary plans had been drawn, a panel with meters mounted on it was set up according to design plans in reference to the lights. Shifting the panel forward and back and up and down permitted field tests to determine where the fixtures should be placed to give the least glare on instrument faces as well as the de-

(*Continued on page* 616)

Authors: Central Arizona Light & Power Co., Phoenix, Arizona.



Branch Office A

In many cases, custom built lighting jobs can give an effect of distinction and still not be more expensive than installations using conventional luminaires. The window in this office was designed to be an example of low cost, custom built lighting. The details of construction are simple and the complete installation with the exception of the rough-in wiring was installed after the plastering of the building had been completed.

Cleats, one inch by three inches, are fastened to the ceiling with screws, parallel with the window glass, spaced 12 inches apart. Fastened to the back edge of the cleats are one-inch by 12-inch boards, scalloped on the lower edge. Single-lamp 40-watt luminaires are fastened to the ceiling in continuous rows between boards. Spacers are installed between the boards at four-foot intervals to control warp and to give some additional shielding in the longitudinal direction.

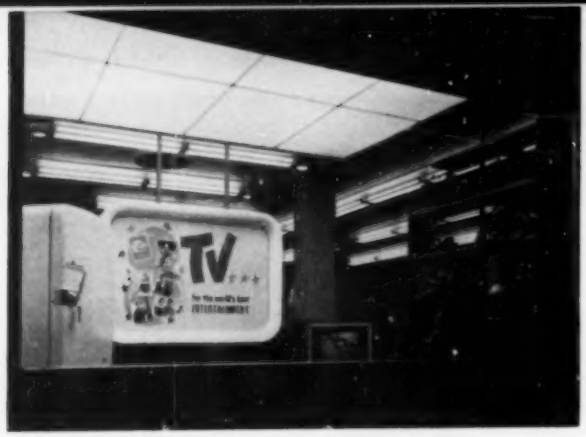
At the front, the fluorescent fixtures are omitted and swivel-type units are installed on two-foot centers, using R40 spots fitted with concentric ring louvers. Four additional porcelain receptacles have been provided along with duplex receptacles for the use of supplementary equipment.

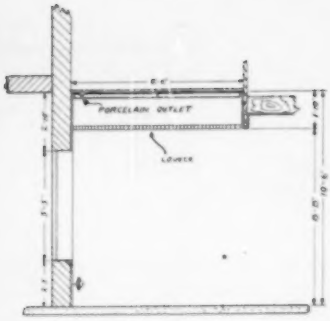
The rear of the window area is cased by a frame of channel lighting built of one-inch by 12-inch stock extending across the top and down each side. Two-lamp continuous row lighting is available in these channels for background color. At the front in the corner, a similar arrangement was constructed to provide a vertical channel for two-lamp 40-watt units. On the side next to the entrance, two-inch by 10-inch vertical louvers are installed, both for decoration and for control of glare from the window itself. Eight duplex receptacles are provided below the glass and along the wall at the side of the window area. All overhead louvers and inside channel surfaces were painted flat white. Vertical louvers are a light cream color while the rest of the window area has been painted to match the office area.

Standard cool white, deluxe cool white, and deluxe warm white lamps are installed between the boards, forming the louvers while colored tubes are used in the channels. Demonstration of the various colors is unusually good in this window because the light comes from the bare tube with no obstructions from louvers or other devices to modify it. With all lamps on, the reflection of the different colors from the white louvers makes a very pleasing effect. A level of about 230 footcandles is obtained with the lamps and the 150-watt spotlights all burning.

Shielding on this installation is such that no glare comes from the window lighting to the office area. From a very limited area only, can light sources be seen. The colored tube channels permit grouping window displays against a background of colored light and the result is very effective.

This window area is large enough to give an idea of what this kind of lighting would look like over the whole ceiling of a small store.





Branch Office B

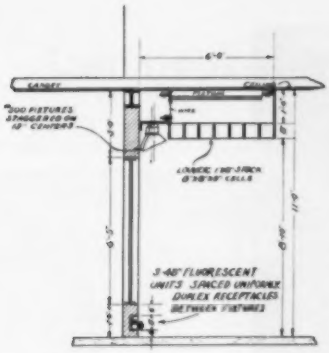
In this neighborhood "model," window area is 8 feet 3 inches by 12 feet. The ceiling was raised to permit 16 luminaires to be mounted 18 inches above a louvered ceiling system. Four porcelain lamp receptacles were spaced above the louver with five more along the front wall, also above the louver. These permit the use of 300-watt R40 floods. Also, two-foot extension rods can be used with adaptors to bring swivel units down below the louver if necessary. Five duplex receptacles were provided under the window itself. Standard cool white, standard warm white, and deluxe cool white lamps are used, spaced and switched so that each color shows fairly even distribution over the entire louver when used independently. This arrangement makes it possible to demonstrate the results of using incandescent and each of the three fluorescent colors without changing lamps in the window. Combinations of colors can also be demonstrated. At present, 150-watt R40 floods are being used in the receptacles and with the lamps described, a total illumination level of 450 footcandles is maintained. Larger incandescent lamps and replacement of the deluxe lamps with standard white, would make higher levels easily obtained.

The office interior, not shown, features two-lamp 40-watt luminaires providing an average of approximately 68 footcandles.

Branch Office C

At this branch, the lighting for the window was designed to demonstrate the ease with which an existing building could be well illuminated. Three commercial window luminaires and four spotlights were placed above the glass. Over the window area four units with matching spotlight fixtures were hung. All lamps used are standard cool white, while the spotlights are 150-watt PAR38.

In the front corner of the window a vertical one-inch by twelve-inch board was installed with two four-foot units in continuous row behind it. Colored lamps are used here to give a splash of color for background lighting. Again, plenty of duplex receptacles are provided for convenience. Illumination level runs 150 footcandles.



Branch Office D

In the 6 ft by 16 ft window area of this branch office, the louver shown was constructed on the job from one-inch by eight-inch stock. Cells are 8 x 8 x 8 inches, giving 45° shielding in both directions. Louvers and cavity are both painted flat white. The louver was hung 18 inches below the ceiling and closed in at the end. Along the front edge of the louver, space was provided for fifteen reflector luminaires hung on 13-inch centers. These have mogul bases and take up to a 500-watt clear lamp, and are hung so that the edge of the reflector is just below the edge of the louver. Removable sections are provided in the louver for relamping and maintenance. Eight duplex receptacles are provided above the louver for the use of lampholders and reflector type lamps to be clamped on the louver itself in whatever position might be required.

Eighteen luminaires are hung in the cavity, at an angle for better shadow control on the louver blades. These are lamped with standard white, deluxe cool white, and deluxe warm white lamps. Below the window glass three reflector type, 40-watt fluorescent units are recessed in the wall for additional vertical lighting, lamped with standard cool white fluorescent lamps. Duplex receptacles are also provided.

At present, the reflector units use 200-watt lamps and the illumination on the floor is 400 footcandles. Of course, with 500-watt lamps this could be increased. The units under the windows provide an additional 15 or 20 footcandles vertical and this helps to improve the appearance of the window at night.

Fundamentally, this arrangement is very flexible and practical but in general application some things should be noted. The component of light from the overhead fluorescent fixtures is not enough to balance the amount of light that can be secured from the incandescent lamps. Heat from the installation is quite high and it would be well to provide a duct from the air conditioning installation to cool the window area. Since the window is not enclosed at the back, glare from the open luminaires is quite bad at the back of the office but this will be controlled by an additional three-foot valance hung from the back edge of the louvered area. However, window reflectance can be greatly reduced with the present arrangement and the window stands out from every store in the vicinity at night, both because of the quantity and the quality of the lighting used.

In the office interior three-lamp troffers are used, providing a maintained average of 77 footcandles. The area here is 25 ft by 50 ft, with an 11-foot ceiling. Each troffer uses three 96-inch 430 ma lamps for general lighting, with swivel-type downlights in the display area, matched with tile-type units in the other rows.

Branch Office E

Unlike the other buildings, which were built to the company's own specifications, this branch was already completed when leased. Since this is the way many small businesses secure their establishments, the existing window was not disturbed. The glass reached to a point on a level with the ceiling and no valance for concealing light has been provided. Recessed fluorescent luminaires could not be installed on the existing ceiling because of the beams, and recessed incandescent seemed to be the answer.

Five of these units employ 300-watt inside frosted lamps, and the seven swivel type use 150-watt R40 floods or spots as needed. All units are well shielded with concentric ring louvers and color lenses are being used. Duplex receptacles have been added for the use of portable equipment.

Maximum footcandle levels have not been established because color lens are being used, but the window is considerably brighter than others in the vicinity and the light is well distributed throughout, making for high quality. This particular lighting installation is relatively low in cost and has a wide application among small businesses.

The office area itself is 68 ft by 24 ft with a 10-foot ceiling. Three-lamp 40-watt luminaires provide 75 footcandles through the office area.

(*Continued from page* 612)

sired amount of light to be used in the particular installation. It was found by this test that original dimensions as calculated had to be changed a little to give the best results.

A restaurant owner who has been planning a remodeling program for his establishment was shown three window and overhead systems. In the near future his cocktail lounge will have a louver-all ceiling section in the center, his dining room will have recessed fluorescent lighting, and niches will be placed on the outside, instead of large windows, for display purposes. This man was able to visualize his proposed new lighting by being able to see full scale examples.

Luminous-Ceiling Dining Room

LIGHTING OBJECTIVE: To provide flexible, decorative general lighting for eating and conversation.

Installation in residence of Ray Forsythe, Birmingham, Michigan; interior designer: Walter Kruke, Detroit, Michigan.

General information: The room is 15′ x 16′ 6″ x 14′ 3″ with an 8′ x 4′ skylight centered in the ceiling. Room finishes are as follows:

walls	olive green	50% RF
woodwork	birch	50% RF
carpet	beige	25% RF
furniture		
wood	birch	
chair seats and backs	chartreuse	

Draperies (not shown in the photograph) are used across one entire side of the room to conceal four sliding glass doors leading to an inside grill. The built-in cabinets have recessed glass-enclosed fluorescent lighting to provide supplementary accent lighting on the china displayed.

Installation: Four rows of 40-watt fluorescent lamps are spaced as shown in Figure 3 on the ceiling of the aluminum-foil lined cavity. The cavity extends 60 inches above 32-inch square panels of ¼-inch thick Rohm and Haas diffusing plastic. White, pink and gold lamps are switched separately to allow the selection and mixing of color and lighting level to suit the atmosphere or occasion.

Figure 2. Aluminum-foil lined cavity and skylight and and framing which supports plastic.

(over)

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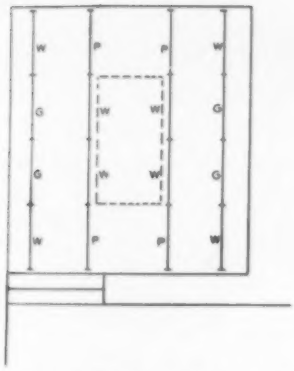

W—White (3500K) 48-inch T-12 single-pin instant start fluorescent lamp.

P—Pink 40-watt bipin preheat start fluorescent lamp

G—Gold 40-watt bipin preheat start fluorescent lamp

Figure 3. Plan view showing lamp locations.

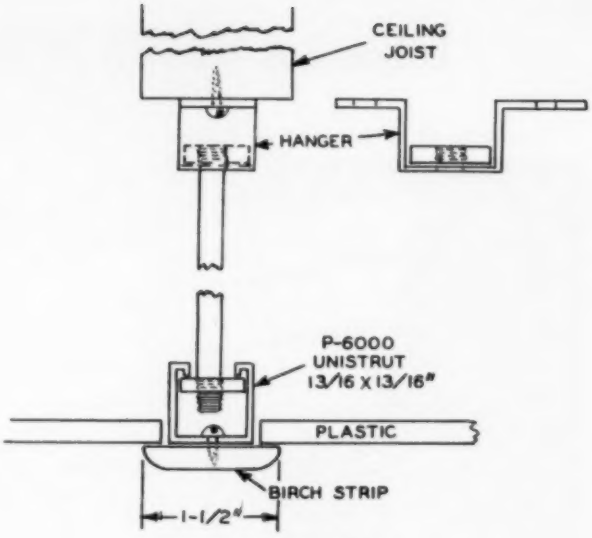

Figure 4. Construction detail.

Average illumination levels and the maximum brightnesses viewed from the entrance doorway at night are indicated below:

		ceiling	wall*
Pink lamps	4.6 ft-c	6.5 ft-L	1.4 ft-L
Gold lamps	4.4 ft-c	7 ft-L	1.4 ft-L
White lamps	12.9 ft-c	22 ft-L	3.7 ft-L
All lamps	21.9 ft-c	30 ft-L	5.3 ft-L

*4' 6" above floor.

Floor brightness is 4.0 footlamberts and luminous ceiling brightness viewed straight up is 40 footlamberts with all lamps operating.

Excellent diffusion characteristics of the luminous ceiling type installation are evidenced as follows:

Footlambert Brightness Ratios

Ceiling Maximum to Wall Minimum

Lamps Operating	Footlamberts	Ratio
Pink and gold	13.0 to 2.0	6.5 to 1.0
Pink	6.5 to 1.0	6.5 to 1.0
Gold	7.0 to 1.3	5.4 to 1.0
White	22.0 to 3.1	7.1 to 1.0
All	30.0 to 4.5	6.65 to 1.0

Lighting data submitted by L. E. Mueller and R. E. Bandfield of the Detroit Edison Company as an illustration of unusual lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society
1860 Broadway, New York 23, N. Y.

Series XVI 12-51

A New Laboratory for Lighting Design Data

By WENTWORTH M. POTTER
ANSON H. RUSSELL

Developments in light sources, new lighting techniques and trends in lighting practice have brought with them a need for tested design data applicable to many conditions not covered by the long-familiar Harrison-Anderson room-index and utilization data. To facilitate production of required new information, a new laboratory has been created at Nela Park. The unique facilities are highly flexible as to room dimensions, reflectance of surfaces and type of lighting system. Explorations of illumination in any desired plane are made with a high-precision, mechanically-propelled photometric head. The results are automatically recorded and computation of utilization data similarly facilitated. Thus, the laboratory lends itself to comprehensive systematic studies as well as checks on unusual situations through the use of mock-ups.

FOR MORE than 30 years, the progress of lighting has been greatly furthered by the basic data for quantitative design contributed by Harrison and Anderson.[1, 2] The acceptance of their room-index method and utilization data has been world-wide. They met effectively the requirements of general lighting practice with filament lamps as conventionally applied for uniform general illumination.

In the intervening years the art has been greatly enriched with new light sources of quite other dimensions, with new techniques of lighting, and by trends in practice having a growing concern with varied brightness patterns and their effect on comfort and appearance and with more interesting form and placement of lighting elements. As a result, it is increasingly true that once installed, a revision of the lighting, or a change in the illumination values becomes relatively much more costly —indeed often impracticable.

On the other hand, predetermination of results often requires data not now available. The Harrison-Anderson tables have been extrapolated[3] to extend their application somewhat beyond the conditions tested, but with increasing uncertainty, even when supplemented by tedious point-by-point computations. The old data are not relevant for lighting elements of the dimensions and placement, for conditions of room occupancy and for appointments with reflectances often found today. They include no information on results on the important vertical or oblique planes. In more and more cases, one is interested as well in lighting results in localized areas and in the over-all contribution made by supplementary lighting directed primarily toward them.

To be sure, the interflectance method[4, 5] of illumination calculation has been an important help in filling gaps in our technology. But again, it is of chief interest in the less complicated situations. Its usefulness could be extended by correlation with a wide range of actual test information.

What has been needed, therefore, are highly flexible facilities which would encompass a wide range of room sizes, proportions and shapes, of reflectance values of the various room surfaces; of location, size and form of lighting elements; and of light distribution. A structure was accordingly designed consisting of assemblies of lengths of quickly-demountable steel channel, which, like the parts of a child's construction set, can be unbolted, or unclamped, and reinstalled in other positions.

Also needed are equally flexible facilities adaptable to measurements of illumination and brightness in any plane. The range of information needed is so great that if measurements were made in the conventional manner, the undertaking would be so formidable as to be altogether discouraging. And so instrumentation was devised for mechanizing the process.

The test rooms were planned to utilize a variable ceiling height reaching to the top of the available space on the one hand, and dropping low enough to achieve room proportions found in very large areas. Lateral size was kept within bounds permitting ready change in set-up, yet providing rooms up to 30 feet square so that subjective appraisals of comfort could be made at substantially full scale. The room of smallest lateral dimensions, with maximum ceiling height of 16 feet, is shown in Fig. 1; its size was dictated by the desired range

A paper presented at the National Technical Conference of the Illuminating Engineering Society, August 27-30, 1951, Washington, D. C. Authors: Engineering Department, Lamp Division, General Electric Co., Nela Park, Cleveland, Ohio.

Figure 1. The smallest square room of the new laboratory (12½ ft x 12½ ft) with maximum ceiling height of 16 feet. Two wall panels removed to show interior.

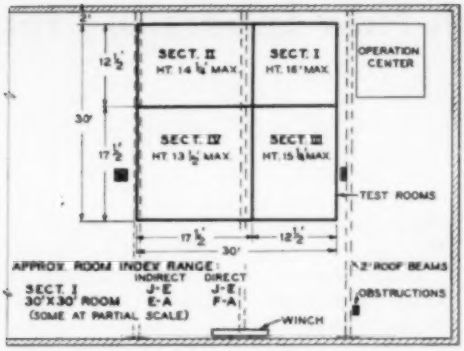

Figure 2. Wide ranges of room proportions are afforded by this general plan, which utilizes all the available area and roof height. The smallest room is positioned for maximum ceiling height to attain a room index of (J) or beyond.

of proportions for smaller areas and by the lengths of fluorescent lamps and luminaires. The general plan is indicated in Fig. 2. The limitations of working in miniature are avoided; there is opportunity for checking a considerable range of room proportions at both full and somewhat reduced scale to ascertain the effect of scale tests with luminaires of normal size. Another opportunity afforded is that of exploring the usefulness of the several expressions for room proportions.

Structural Elements

Ceilings.—For support of lighting elements and ceilings, four demountable grids, corresponding to the four sections of the general plan, are provided. The basic rigid members of each grid are two lightweight 6-inch steel I-beams, across which heavy channel members are clamped. One half-inch wall clearance is provided. Four wire ropes of the hoisting system, attached to the I-beams, support each grid section, and raise and lower it alone or in synchronism with connected adjacent sections for larger square or rectangular rooms. The necessary uniform motion is secured by controlling all ropes with a single motor-driven winch. Thus, ready and rapid means of changing ceiling height and room proportions are available.

Ceiling surfaces, either opaque reflecting or translucent, are supported by secondary structural members attached to the grids. Trans-illuminated panels or ceilings of louvers or diffusing materials may be hung below a reflecting cavity and lamps. Conventional luminaires may be located anywhere and readily shifted. Recessed types may penetrate the grid between beams.

Walls.—The wall structure, which supports the lightweight reflecting surfaces, consists of vertical light steel channels spaced as needed and clamped top and bottom to similar horizontal members. Coves or other lighting elements may be readily attached. Actual doors and windows can be built-in or simulated as desired.

Floor.—Since the existing concrete floor is not level, moveable floor sections of 4 ft. x 8 ft. plywood sheets on light frames are used.

Reflecting Surfaces.—Wall, ceiling and floor reflecting surfaces consist of sheets of double-faced corrugated carton board, finished with different reflectances on opposite sides. Patterns of varied reflectance and color are readily obtained. Flanges for support of ceiling panels are covered with masking tape lacquered to match ceiling reflectance.

Photometric Equipment

Flexibility and adaptability to automatic recording of results, as well as accuracy, have been objectives in devising this equipment.

Light-sensitive Cells.—Cosine correction of a high order is recognized as essential for accurate measurement of illumination. It is especially important with extensive, diffusing elements and highly reflecting walls, and in evaluations such as of vertical illumination where light from the principal sources is incident at high angles.

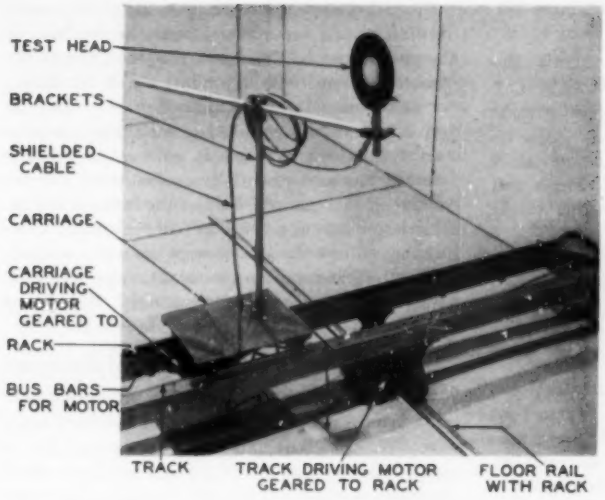

Figure 3. Test head, carriage and track assembly. Adjustable brackets permit cell to be positioned at any height, angle of elevation or angle in azimuth. Cell may be quickly removed for calibration without disconnection. Track and floor rails are extended with additional sections for traversing larger spaces.

Therefore, a new type of test head* with excellent cosine correction, particularly at high angles,[6] is used. The barrier-layer element is placed within a small turret of translucent methacrylate plastic. This device, shown in Fig 3, includes a shield whose rim prevents acceptance of light from any point beyond the plane of the cell turret. A disk-type element is used for uniform acceptance of light from all directions. Superposed are a Wratten No. 102 filter for color correction and a neutral density filter. Since cells respond most accurately at low energy levels and adequate sensitivity of the recording apparatus is available, neutral filters of transmittance as low as 0.015 have been selected.

The Recording Instrument.—Signals from the cell are conducted by shielded cable to an automatic current recorder, Fig. 4, of the slidewire null type.[7] It has a 10-inch, 100-division scale; its strip chart with rectangular coordinates is well adapted to geographical plotting. As the cell is moved in the room by means described below, this instrument records illumination values in continuous curves. It is expected that the recorder will

*Further described in an article, "An Illumination Recorder," by A. H. Taylor and W. G. Pracejus, published in ILLUMINATING ENGINEERING, June 1951.

Figure 4. Operation center. (A) control panel for scanning equipment, recorder and intgerator. (B) automatic recording instrument. (C) integrator. (D) winch control button. Voltmeter and controls for test and calibrating lamps and for integrator circuits, left.

also be adaptable to analogous procedures for measurement of brightness.

Sensitivity of the system may be varied with the three ranges of the recorder, with ratios of 1, 2 and 5, and the two test heads with different neutral filters. With their several combinations, full-scale deflection may be produced by illumination values ranging from 2.5 to 250 footcandles. For a cell without neutral filter, the same deflection would require only 0.8 footcandles.

The speed of response of the instrument, about 1½ seconds zero to full-scale deflection, appears adequate for correct indication of high gradients in illumination at the low speed of cell travel (about 1⅞ inches per second.)

Linearity.—A high degree of linearity is necessary in plotting continuous curves; corrections would be impracticable. Cell elements have been selected which, in combination with the recorder, provide closely linear response. The maximum error, at any point on the scale, is a small fraction of a division. This characteristic is easily checked from time to time with a bar photometer located just outside the test room.

Calibration.—The cell-recorder combination is calibrated against a carefully selected and seasoned 1000-watt T-20 C-13 filament clear lamp which is positioned on the bar photometer at calculated distances from the carefully baffled test head. Frequent interim checks and adjustment of recorder response are afforded by standardization equipment contained in the recorder itself.

Control of Deflection.—In many situations, peaks of illumination occur which must be confined to the recorder scale. Means to this end include the changes in sensitivity described above. However, for finer control of peak deflection with filament test lamps, voltage supplied to such lamps may be varied provided the cell is color-corrected, the room surfaces are essentially non-selective, and the voltage-lumen characteristic of the lamp is known. This latter function has been determined by placing the cell in a fixed position in the test room and, with all other conditions constant, recording relative deflections for different voltages. Here again linearity of the cell-recorder is essential.

Control Equipment

Searching Mechanism.—Continuous recording of data requires controlled motion of the light-sensitive cell. In illumination measurements, this is provided by mounting it upon a carriage which traverses a chosen space on a track*. This track in turn moves transversely upon floor rails. See Fig. 3.

Carriage and track are moved by their own synchronous motors which are controlled by adjustable limit switches. An ingenious circuit and associated equipment provides either manual control by push button at the operation center, or an automatic cycle of operation of carriage and track. Thus the cell may be moved to any position, a peak of illumination searched out, or a complete test

*Higbie in 1934 employed mechanical scanning and oscillographic recording for illumination measurements in small model rooms.[5]

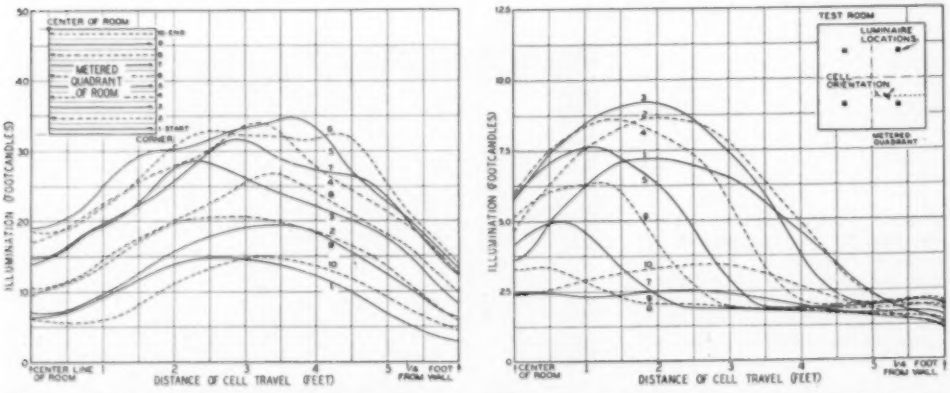

Figure 5. Typical illumination distributions recorded in a quadrant of a 12½′ x 12½′ room of ratio 0.8 with surface reflectances: ceiling, 0.80; wall, 0.40; floor, 0.17. Sources, 150-watt PAR-38 Floods, shielded to 45°, operated at about 100 volts. Units centered over quadrants. Chart A (left) indicates horizontal illumination along centers of 7½″ strips 30″ above floor. Chart B (right) shows the corresponding distribution of vertical illumination for one orientation only. For equal source output the ratio of averages is 0.18. (Curve position has been adjusted laterally to eliminate the offsetting effect of strip-chart over-travel.) (Chart paper moves 1″ for each 6″ of cell travel.)

taken, all without the operator entering the room. In automatic scanning of an area, the cell starts at a corner and traverses a strip of area along the wall. At the end it stops while the track moves a predetermined distance; then it reverses and continues to make such consecutive traverses in opposite directions. For example, in some tests, the cell center moves in lines 7½" apart; ten such traverses explore a quadrant of the 12½ ft. x 12½ ft. room.

The paper strip-chart of the recorder is also controlled by this circuit during automatic operation. Its driving motor moves and stops it in synchronism with the cell, reversing direction for successive traverses to conserve paper. The permanent record of illumination values thus made is available for averaging, calculation of coefficients and studies of distribution. Examples of such recordings are shown in Fig. 5.

Voltage Control. — All photometric equipment and test lamps are operated on 60-cycle alternating current regulated by automatic voltage stabilizers. Variable auto-transformers, suitably connected, provide both coarse adjustment of voltage, and finer control as needed for calibration.

In the case of filament test lamps, voltage to each is adjusted individually for equal lumen output to preserve symmetry in the test room. Voltage is measured at the lampholder.

Automatic Integration of Curves

To eliminate the considerable time involved in tedious averaging of recorded curves, such as shown in Fig. 5, and thus to expedite production of data, an automatic integrator was devised.

This instrument, shown in Fig. 4, operates only when the cell carriage moves on its track. It has as its essential part a modified watthour-meter element without gears or indicating dials. The current coil carries a constant load.

The integrator is controlled by the recorder through a rotary potentiometer so connected to the recorder indicating mechanism that contact movement is proportional to deflection. As deflection changes, varying voltage is impressed on the voltage coil of the watthour-meter, thus varying the speed of rotation of the meter disk.

The disk itself has holes accurately spaced near its periphery. As it rotates, these holes allow light from a small lamp to energize a small phototube and its amplifier circuit. This in turn actuates a solenoid counter. Counts are registered during a test at speeds proportional to illumination on the cell and the total is available the instant cell motion ceases. This figure is quickly convertible, with proper constants and scale factors, to average illumination or to total lumens incident on the plane of measurement. Coefficients of utilization calculated from values so obtained in exploratory tests are plotted in Figs. 6 and 7.

Results of the automatic integration process are compared in Table I with those obtained by averaging ordinates of recorder curves. For most con-

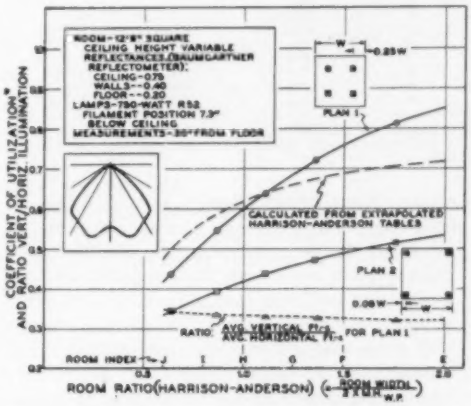

Figure 6. The solid curves show measured coefficients of utilization for two locations of direct lighting units. The R-52 reflector lamp, designed primarily for high-bay industrial service, was used in each case. The dashed curve is calculated from an extrapolation of the Harrison-Anderson tables, which were based on a uniform distribution of room illumination. Dotted curve indicates the average vertical illumination, as a fraction of the horizontal value, averaged for eight orientations about a vertical axis. *Coefficients express flux received on the horizontal plane of measurement as a fraction of the initial output of a general-service lamp of the same wattage.

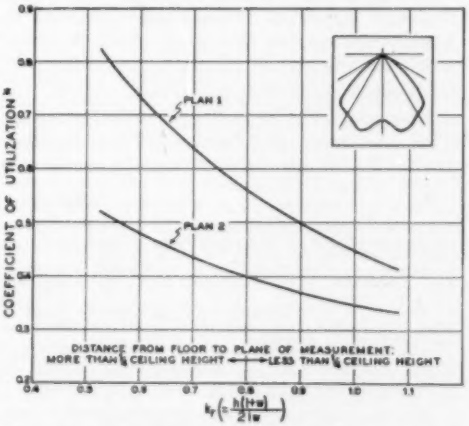
PLAN 1
PLAN 2
DISTANCE FROM FLOOR TO PLANE OF MEASUREMENT:
MORE THAN ⅓ CEILING HEIGHT
LESS THAN ⅓ CEILING HEIGHT
COEFFICIENT OF UTILIZATION*

Figure 7. Coefficients of utilization for the solid curves of Fig. 6 plotted with k_r, the index of room proportion proposed in the interflectance theory, as abscissa.

TABLE I.—Comparison of Automatic Integrator Results With Integration by Averaging Ordinates.*

Integrator Check No.	Lumens Delivered: By Automatic Integrator Count	Lumens Delivered: By Averaged Ordinates**	Integrator Error in Per Cent
1	2,750	2,726	+0.88
2	1,959	1,964	−0.25
3	586	586	——
4	664	663	+0.15
5	604	607	−0.49
6	509	506	+0.59
7	1,004	1,004	——
8	709	710	−0.14
9	199	196	+1.53
10	524	529	−0.95

*Computed for recorded curves chosen at random.
**Two hundred forty equally-spaced ordinates were averaged for each.

ditions involving considerable and changing deflections, the linearity curve of the integrator is averaged. However, at very low deflections, the point-by-point departures from linearity are relatively large and may change from plus to minus at points one division apart. Therefore, a traverse with a constant low deflection may exhibit a substantial error in counts. Such errors are reduced by avoiding extremes of deflection whenever practicable. With still better accuracy over the whole scale as a goal, another type of integrator is under study.

Acknowledgments

The project here reported was initiated by a group with responsibilities for lighting design information including C. L. Amick, G. R. Baumgartner, E. A. Linsday, O. P. Meaker, W. M. Potter and C. E. Weitz. Prof. E. K. Kraybill, Duke niversity, participated in preliminary planning during a summer period, together with R. D. Churchill and C. N. Clark. Prof. Wendell E. Miller, University of Illinois and Omer D. Whitwell, Case Institute of Technology, contributed to construction, equipment and control circuits. Instrumentation was devised with the collaboration of A. H. Taylor, Del Kershaw, W. G. Pracejus and H. E. Schultz.

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DISCUSSION

BENJAMIN S. BENSON, JR.*: The paper by Potter and Russell has been perused with interest and I would like to compliment these men and their associates on a job—not well *done*—but well *begun*. It is much easier to build a shovel than to wear it out and I appreciate the task in store for the authors in refining their techniques, obtaining their data and interpreting their result.

My comments are not concerned with the physical aspects of the laboratory itself, which is a fine example of private enterprise at work, but with a discussion of the technique for its use.

The authors mention that the lumen output of each filament lamp is matched by individual voltage control. This is necessary due to the small quantity of lamps involved and the fact that only one quadrant of the area is measured. For the same reason it would be highly desirable to also match the individual light distributions. This the authors may have done without making mention of it in their paper.

Since the authors have used reflector lamps for their illustrated data it might be well to point out the possible variation in individual light distributions which could be encountered.

Figure X reproduces a graph[1] of the individual light distribution for a quantity of 150-watt, R40 reflector spot lamps. There is quite a difference in the shapes of these curves, and if not taken into consideration, might well affect the illumination balance in the room.

Figure Y represents the candlepower distributions of two 750-watt, R-52 reflector lamps. Here again is indicated that variation in unmatched distributions might cause erroneous results.

In Figure Z illumination curves have been plotted from the authors' Chart A (Figure 5) which might indicate unmatched candlepower distributions of the PAR-38 lamps. Curve OA represents the 10th traverse leg on the authors' chart. Curve OB represents a hypothetical traverse on a corresponding leg at right angles to OA. Since the data for curve OB was taken from the same exploration we could expect curves OA and OB to coincide more nearly than they do.

The problems, not only of unmatched light distributions, but of lamp orientation (in the case of non-symmetrical candlepower distribution about the lamp axis) are ones which the authors might care to discuss further.

The authors' Figure 6 is interesting in that it indicates the influences of luminaire location upon the coefficient of utilization. In their Plan 1 is shown what would be a normal spacing pattern for 4 luminaires in a square room. While Plan 2 shows an abnormal spacing pattern under the same conditions, there are a great many installations where *some* of the luminaires are so located. In Plan 1 the center area bounded by the four outlet locations represents only 25 per cent of the total area while the remaining 75 per cent

*Benjamin Electric Mfg. Co., Des Plaines, Ill.

1. Brown, L. C., and Presbrey, Priscilla: "Application Data for Downlighting Equipment," ILLUMINATING ENGINEERING, Vol. XLIII, No. 1, p. 14 (January 1948).

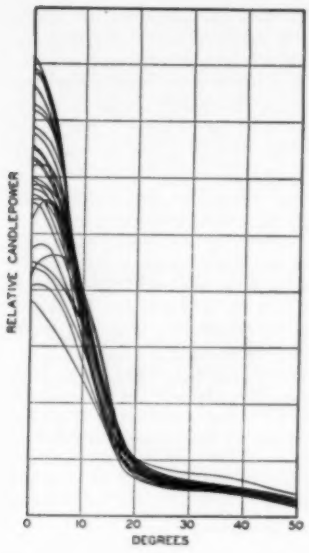

Figure X. (left).

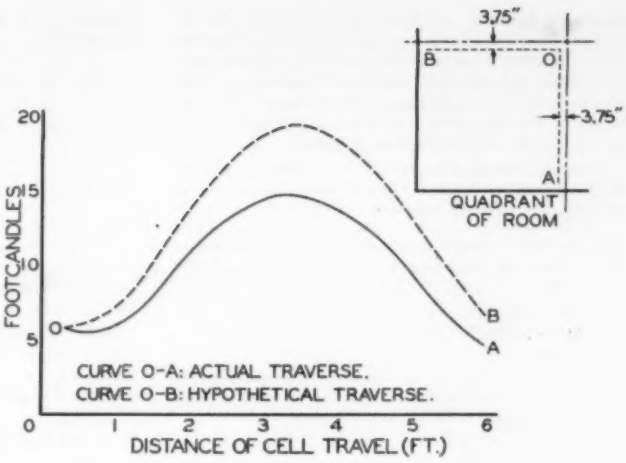

Figure Y. (above).

falls in the seemingly narrow strips between the outlets and the walls. For uniformly spaced luminaires, in such quantities as are found on the job today, 75 per cent fall within the strips whose width is only 0.25 W. The actual coefficient of utilization for any given room index will most times fall somewhere between the curves for Plan 1 and Plan 2. Just where depends upon the quantity of uniformly spaced outlets. This poses an interesting question. Should we include one more factor in the lumen-method formula—a "quantity of outlets" factor? I am sure that with their new laboratory the authors can, in time, provide us with an answer to this question.

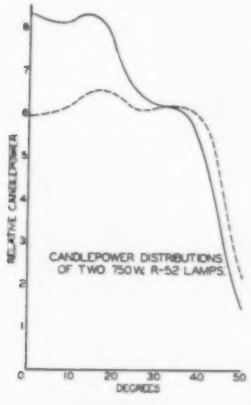

Figure Z.

R. B. BROWN, JR.*: The authors and their associates in this project should be commended first for their forthright approach, and second for their ingenuity and apparent skill in devising the instrumentation phase. Despite all the good work that has been done in recent years to develop the mathematical approach to predetermination of results we all know that real situations are far too complicated in many cases to permit a degree of precision which the process itself would imply. Experimental science is still good science and in my opinion there is no adequate substitute for full-scale experimental mock-ups to give us solid data.

The instrumentation devised for this laboratory indicates that we are beginning to adopt some of the ingenuity and skill that has been commonplace in the field of electronics for years. To anyone familiar with modern control devices, particularly those developed for military use during and since the recent war, one can envision interesting possibilities such as the authors have described and on a more extensive scale. For example, is it beyond the realm of possibility to utilize electronic scanning in studies of brightness patterns? Messrs. Potter, Russell and their co-workers have made a start in the right direction and I have no doubt that in time they will have made a contribution to illuminating engineering that will compare very favorably with the monumental work of their predecessors Harrison and Anderson.

EDWARD K. KRAYBILL**: The rather matter-of-fact presentation of Potter and Russell modestly ignores the exciting and far-reaching significance of the results that may be obtained from the new Lighting Facilities Laboratory at Nela Park. As one contemplates the possibilities that will exist in research on basic illumination design, the effect is startling.

*Boston Edison Co., Boston, Mass.

**Department of Electrical Engineering, Duke University, Durham, N. C.

In a sense it is hard to believe that in a period of over 30 years no individual or group has succeeded in obtaining data to completely supersede (or nullify) the valuable work of Harrison and Anderson. With the versatile and flexible facilities announced in this paper it would appear that now it will be possible to obtain far more accurate, comprehensive and widely useful data than heretofore.

It will be possible, if so desired, to re-examine any of the Harrison-Anderson data. Greater accuracy should be possible for the following reasons:

1. Without observers in the test room no shielding of instruments or change in reflectance values will take place.
2. Recording instruments are generally considered to be more consistent than visual balances performed by persons.
3. With the automatic recording apparatus many more points can be obtained in a given period of time than by the personal visual balance method.
4. Present-day instruments with proper cosine and color correction provide readings more accurate than anything possible 30 years ago.
5. Calibration of lamps used in the tests, and control over their output, now can be held to limits much closer than a few decades ago.

As mentioned in the introductory portion of the paper, the new laboratory will provide a wide range of room sizes, proportions, shapes and reflectance values; of location, size and form of lighting elements; and of light distribution. The resulting opportunities presented by such combinations should be readily apparent to even the casual reader.

With the test head described in the paper it will be possible to sweep a given test room at almost any level, rather than limiting all observations to a plane 30 inches above the floor. Moreover, observations on vertical planes or on planes other than horizontal or vertical will provide new areas for examination.

Among new and little-tried tests are studies of room brightnesses. Almost innumerable possibilities exist for research on many aspects of brightness. It might well be that a comprehensive study of brightness could be one of the most fertile fields for the new laboratory.

The authors point out that scaling-down and working in miniatures was avoided insofar as possible. Such practice would appear to be wise because of the numerous unforeseen errors which frequently sneak into experiments conducted on and with miniatures or models. Further, the opportunity for subjective appraisal with full-size test units is a valuable asset to experimental work in illumination particularly.

It might be noted that by a slight modification in the design of the test head to obtain a narrow cell, perhaps a foot or more in length, it should be possible to sweep completely a given plane in the room and thereby obtain average illumination directly from the integrator without resorting to curves or other observed data. Such a procedure would be both rapid and accurate for obtaining certain limited information.

The paper presents very well an over-all picture of the need for a lighting facilities laboratory, the construction of the laboratory and its equipment, and a few of the various types of research possible with such facilities.

WENDELL E. MILLER*: Since the publication of "Coefficients of Utilization" by Dr. Ward Harrison and Mr. E. A. Anderson in 1920, we have seen many advancements in the sources of illumination as well as in the techniques of measurement and the design of illumination equipment. While the Harrison-Anderson table of coefficients has served notably well, it is essential that a study, such as is described in this paper, be undertaken to expand this information in order that the methods of illumination calculation can keep pace with the physical advancements mentioned above.

Having been closely connected, for a short time, with this project, I know that a great deal of planning and work has gone into the construction of this equipment to insure completeness and accuracy of the end results. I am certain that this undertaking will contribute a great deal to the field of illuminating engineering.

There are a multitude of conditions which can be simulated in this laboratory. The room size and ceiling height are variable, the type of light source and type of fixture can be rapidly changed and the reflection factors of ceiling, floor and walls may be easily varied. There are, however, a few details, as listed below, which probably should be taken into account. Undoubtedly the authors have considered these in their thinking:

1. What effect does the presence of windows and furniture, in a room, especially light topped desks, have upon the coefficient of utilization?
2. The presence of a rug on a floor or an asphalt or rubber tiled floor often presents the problem of a double reflection factor surface. Will these conditions be studied in this laboratory?
3. Will the shadows created by the recording apparatus cause any appreciable error in the results?
4. How will the degree of specularity of the reflecting surfaces be taken into account?

I raise the above questions with an attitude of great interest in this project rather than that of criticism.

W. M. POTTER**: We are aware that variations in candlepower distribution among the test units could result in asymmetric distribution of illumination and error in utilization values. Consequently, all test units are carefully photometered and selected for consistent and representative distribution—a very considerable task in some cases, as Mr. Benson has indicated.

Similarly, asymmetry in candlepower distribution about a vertical axis may introduce error when results for random orientation are desired. The asymmetry indicated in the curve of Chart A (Fig. 5) appears to be due to this cause rather than to unmatched light distribution from the four units. In some cases, as with R-40 floods, the variations are minor and lamps are readily oriented for excellent symmetry and average results; in others, tests with various orientations of the lamps, or with continuous rotation at a speed which will not distort the source, may be necessary.

Mr. Benson also comments on the effects of luminaire location as suggested in our Fig. 6 for two plans. For a complete exploration of this factor, measurements of addi-

*College of Engineering, University of Illinois, Urbana, Ill.
**Author.

tional plans will, of course, be made. Then coefficients of utilization for different numbers of units spaced either uniformly or non-uniformly, can be determined.

The authors have the matter of brightness pattern, mentioned by both Mr. Brown and Prof. Kraybill, much in mind and are studying possibilities for automatic measurement and recording. Both equipment and procedure are adaptable. The long narrow test head suggested by Prof. Kraybill is useful for rapid utilization measurements but at some sacrifice of distribution detail. With either type of test head, actual recording of curves is unnecessary in obtaining integrated lumens.

Prof. Miller suggests studies of the effects of windows and of the presence and reflecting character of appointments such as furniture and floor coverings. These, together with the effects of personal occupancy, the authors have had in mind; the scale of laboratory rooms will facilitate such studies. The degree of specularity of reflecting surfaces of rooms and appointments will be defined by gonio-photometric measurements, and the effect of variation in this factor can be explored for a range of practical finishes.

There is no indication of appreciable error due to the shadow or absorption of the traversing apparatus; if any, it should tend toward slightly conservative results. The test head is normally mounted offset from the track, especially when close to the floor, to minimize any such effect and to provide latitude in adjustment.

Office Design Planned for Employee Morale

Designed with much thought for employee morale, the new Chicago offices of Westinghouse Electric Corp. feature fluorescent sunlamps and general fluorescent lighting, bactericidal lamps in the ventilating system, air-conditioning throughout, and bright, cheerful colors for walls. General level of illumination is 60 footcandles.

A total of 220 sunlamps are installed on the ceiling over all working areas. Over the general office areas (see photograph) the lamps produce, in an eight-hour day, the equivalent of fifteen minutes in the summer sun.

Various shades of red, green, blue, yellow and brown, as well as two tones of gray, have been used in the color scheme to provide a pleasant working environment. The ceiling is soundproofed, and the entire office is air-conditioned, with 80 bactericidal lamps installed in the ventilating system.

Fundamental Characteristics of Plastics for Fluorescent Lighting

By CORTES N. SPRANKLE

A paper devoted to a general description of plastics with details of characteristics, to provide the basic means of proper selection and use in fluorescent lighting.

DURING the past several years, and especially since the war, plastics have been so widely accepted as an engineering material in the lighting field, that details of their characteristics have become a special interest of illuminating engineers.

Plastics, in their characteristics may be broken down into two basic types: namely thermosetting and thermoplastic, roughly analogous with ferrous and non-ferrous metals. By restricting this discussion to plastics for fluorescent lighting, we automatically limit it to thermoplastics.

Thermosetting plastics are those which cure by chemical action to an infusible state when subjected to heat and pressure. They cannot be resoftened and remolded.

Thermoplastic materials are those which are softened by the application of heat, then molded and shaped, and finally chilled to their molded shape. No chemical reaction takes place and the process can be repeated, though only for a few times due to loss of volatile ingredients and/or deterioration of the plastic ingredients.

Touching briefly on the principal methods of molding or fabrication of plastic sections, *compression molding* is the method used almost exclusively for thermosetting materials. This method consists of placing the plastic material in a hydraulic press where pressure plus heat is applied to the material as the mold is closed. The material "flows" under this heat and pressure to fill the mold and is held under this heat and pressure for sufficient time for the chemical reaction or "cure" to take place. Articles as large as television cabinets can be molded by a modified compression system, known as transfer molding.

Injection molding consists of heating the thermoplastic material to a plastic consistency in a cylinder and then "injecting" this heated material into a closed cold mold by a hydraulic ram. The cold mold chills the material to its new molded form. Maximum sizes for injection molding are limited by the mold clamp pressure. Thirty-two ounce machines can handle maximum sizes of 275 to 300 square inches of area in thickness of $\frac{1}{16}$-inch to $\frac{3}{32}$-inch and up to 400 square inches in thicknesses of $\frac{1}{8}$-inch. One-hundred and 200-ounce presses are not uncommon.

Extrusion is the process whereby granular thermoplastics are fed through a hopper into the rear section of a heated cylinder containing a worm screw, and as the screw conveys the granules forward, they are softened and milled to a plastic state by the heat of the cylinder and the frictional heat generated by the screw. The conveying action of the screw then forces the material through the orifice of the die where it is chilled to shape, customarily by air or water, as the extrusion proceeds continuously. Maximum widths for extruded sections in adequate thicknesses have not yet been determined. It is entirely feasible to produce controlled sections with today's equipment and techniques up to 25 inches to 30 inches developed width. Beyond that will depend on equipment and experience.

Fabricated or formed sections are produced from sheet plastic material which has been heated to forming temperature and then pressed, draped or vacuum drawn to the specific shape using wood or other simple forms.

Proper Material Selection

The primary prerequisite for the successful use of plastics in fluorescent lighting is the proper selection of material. To make this selection, the basic or fundamental requirements must be established for its use. Plastics for fluorescent lighting are important primarily as translucent dispersing, shielding or reflecting materials. Since the type of lighting principle varies with specific lighting requirements and with different theories, the material must be capable of giving a wide range of light transmission; i.e. a material that is preferably water clear in its natural color and with unlimited color or pigmentation possibilities. Quite naturally it is essential that this color be as stable as possible under the normal conditions of its use. Thus the

Author: Vice-President, Sandee Manufacturing Co., Chicago, Ill.

CHART A.—Suggested for Evaluating Thermoplastics for Fluorescent Lighting Applications.

Pertinent Properties	Cellulose Acetate	Cellulose Acetate Butyrate	Ethyl Cellulose	Poly-Ethylene	Methyl Methacrylate	Polystyrene	Rigid Vinyl
Specific Gravity	1.31	1.22	1.12	0.92	1.16	1.06	1.38
Impact Strength 77°F (Notched Izod)	0.9	1.0	2.0	3.0	0.4	0.25	0.4
Heat Distortion Temp 264 PSI	165°F - 190°F	165°F - 190°F	175°F - 190°F	(66 P.S.I.) 107°F	170°F - 210°F	180°F - 210°F	140°F - 153°F
Age-Shrinkage Resistance	Poor to Fair	Fair	Fair	Excellent	Excellent	Excellent	Excellent
Moisture Absorption	1.5 to 2.9	1.0 to 2.2	.8 to 1.8	Nil	Nil	Nil	Nil
Coefficient of Linear Expansion (In. per in. per °F)	7×10^{-6}	7×10^{-6}	7×10^{-6}	10×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}
Rigidity	Fair to Good	Fair to Good	Fair to Good	Fair	Very Good	Very Good	Fair
Abrasion Resistance	Fair to Good	Fair to Good	Fair to Good	Fair	Very Good	Fair to Good	Fair to Good
Burning Rate	Slow	Slow	Slow	Slow	Slow	Slow	Self-Extinguishing
Colorability	Unlimited	Unlimited	Somewhat Limited	Limited	Unlimited	Unlimited	Limited
Color Stability	Fair to Good	Fair to Good	Fair to Good	Excellent	Excellent	Good	Fair

primary requirement for a suitable plastic for lighting is *unlimited, stable, color possibilities.*

The *second fundamental requirement* is dimensional stability. The shielding or reflecting part produced from this material must not warp, twist or otherwise distort under normal operating conditions and it must not shrink nor become brittle on long use.

The diversified nature of the different plastics lead to varying results when exposed to alternate cycles of high and low temperature and/or humidity. Some thermoplastic materials are subject to dimensional change only on exposure to heat, while others are subject in addition, to changing humidity conditions. The latter type are further complicated by the fact that actual shrinkage loss may occur on repeated exposure to changing humidity and temperature conditions.

Some "man-made" plastics are too hard, horny or brittle to be used in their natural state; therefore, soft, compatible materials are blended with the natural plastic to produce a moldable material which is tough for normal average use. These additive materials are called plasticizers and may be liquid, paste or semi-solid. This blending is usually done on hot milling rolls and the resultant blend is, in reality, an admixture with no chemical linkage or bonding. Such an admixture is not permanent and is subject to change in direct relation to the loss of the plasticizer. This loss may result from evaporation, solvent extraction, moisture extraction or simply leaching. Obviously, then, plastics of this type will not only vary to a greater extent in dimensions on exposure to alternate cycles of high and low temperature and humidity, but they are also subject to potential shrinkage in size through gradual loss of plasticizer. Plastics should be sought which are plastic entities within themselves, requiring no plasticizer, and with no moisture absorption. Such plastics will change dimensions only on exposure to heat and no shrinkage will result even on innumerable exposures to changing temperature and humidity conditions.

There is still another functional requirement of extreme importance; namely, heat distortion resistance. This is also a dimensional stability factor; however, the stress placed upon the necessity of having a material that will not sag nor distort under high ambient temperatures requires a separate listing. It is generally conceded that a material that will withstand an *extreme* maximum ambient temperature of 140°F to 150°F is satisfactory. Therefore, heat distortion resistance is listed as the *third fundamental requirement.*

It is likewise important from the fixture design standpoint that the plastic material be as rigid as possible in order to minimize the amount of mechanical support required to prevent sagging. Common engineering principles for increasing rigidity in a section through channel, curved or contoured designs apply also to plastics. High rigidity thus becomes the *fourth fundamental requirement.*

Selection of Plastic Material

Knowing the requirements and general plastic characteristics, the problem is to select the best material for specific application. For comparative properties of those thermoplastics which have been or could be, considered for lighting applications, refer to Chart A. The properties listed are not all-inclusive but have been restricted to those properties pertinent to our subject. Perhaps the quickest way to check these materials would be to compare the characteristics of each individual material in turn against the requirements established. Such a comparison shows the following results.

Cellulose Acetate, Cellulose Acetate-Butyrate and Ethyl Cellulose are generally referred to as "cellulosics"; *i.e.* all are derived from cellulose,

modified by chemical processes to give hard, horny materials. All are compounded with plasticizers to provide moldability and toughness to the molded part. Since these three materials are so closely allied, they can well be considered as a group—noting only that there is a difference in grade between them.

The cellulosics have unlimited colorability, except for water-clear in Ethyl Cellulose. Color stability is fair to good. Heat distortion is quite adequate in the harder formulations. Dimensional stability, in typical fluorescent fixture applications, is poor to fair. As mentioned, the cellulosics contain plasticizers and, in addition, have appreciable moisture absorption; therefore, sections produced from these materials are subject to expansion and contraction as the result of this moisture absorption plus that due to temperature changes. Gradual loss of plasticizer on aging may result in shrinkage, embrittlement and probable discoloration.

Polyethlyene's colorability is limited to translucent white with low light transmission. Its dimensional stability is good; however, its heat distortion point is relatively low. Polyethylene is a soft, semi-flexible material, lacking sufficient rigidity for fluorescent fixture applications.

Rigid Vinyl colorability is limited to translucent whites whose color uniformity is none too good. Also, its color stability is somewhat questionable in thicknesses over $\frac{1}{8}$". Rigid Vinyl has no moisture absorption and, in general, has excellent dimensional stability; however, its heat distortion point is definitely borderline. Its rigidity is only fair, requiring extra mechanical support.

Methyl Methacrylate has unlimited colorability and its color is stable even under outdoor exposure. It has no plasticizer content, no moisture absorption and its dimensional stability is excellent. Its heat distortion resistance is also more than adequate. Methyl Methacrylate has very good rigidity; therefore with proper design, minimum mechanical support is required. Methyl Methacrylate material is one which meets all requirements for successful fluorescent fixture uses.

Polystyrene also has unlimited colorability. Its color has been proved in service to have adequate stability in all open-type fixtures; however, for closed-type or recessed-type fixtures, special light stabilized formulations are recommended. It contains no plasticizer and absorbs no moisture; therefore, it, too, has excellent dimensional stability and more than adequate heat resistance plus very good rigidity.

Since there obviously will be questions as to which is the better material—Methyl Methacrylate or Polystyrene—further comment is indicated. It was noted above that Methyl Methacrylate has "outdoor" color stability and this is of prime importance where long life, guaranteed color stability is an absolute necessity. Polystyrene, especially the light stabilized formulations, are, however, adequate for most normal applications. Volatile and aromatic oils, such as benzol or ingredients in typical furniture polish, will attack Polystyrene, causing crazing and some discoloration. Such adverse effects are not common to Methyl Methacrylate. The latter material has an edge over Polystyrene also on surface finish and abrasion resistance, although this is of little significance in lighting applications.

Economy-wise, the scale swings sharply in favor of Polystyrene. The deluxe characteristics of Methyl Methacrylate, however, must be considered carefully before being ruled out on price only.

Considerably study has been given to flame resistant plastics which are normally inflammable. There is considerable merit to this development, but the effect of these flame proofing ingredients on other properties of the plastics must be determined before widespread usage is warranted.

Probably the most important single factor in the successful use of plastics is the consideration of their coefficients of linear expansion. There *is* a great difference between the coefficient of linear expansion of plastics and metals; however, this difference will *not* cause any trouble, if it is recognized and taken into consideration in fixture design. The importance of this one factor cannot be overstressed.

Chart B gives the average coefficients of linear expansion of the thermoplastics considered here and the coefficients of two metals for comparison. In addition, there are examples of the actual effect of these coefficients as shown by the linear expansion and contraction of 12-inch and 48-inch lengths when the temperature rises or falls from the nominal, or room temperature at which the lengths were cut.

From this chart it can readily be seen that the expansion or contraction of the two selected plastics, namely, Polystyrene and Methyl Methacrylate, are approximately seven to eight times greater than 1C (one carbon) steel and 3½ to 4 times greater than 2S aluminum. This sounds bad, but actually it is not serious in the least *if* it is recognized and allowed for in the design. It should be specified that the plastic shields be cut to a mean length (within a practical, specified temperature range) and then allow sufficient return lip on the end caps to permit the maximum expected expansion

CHART B.—Thermal Expansion and Contraction Data on Rigid Extruded Plastics.

Material	Average** Thermal Expansion In. per In. per °F*	Examples**					
		12-Inch Lengths			48-Inch Lengths		
		0°F	77°F	125°F	0°F	77°F	125°F
Ethyl Cellulose	8.3×10^{-6}	11.923	12.000	12.048	47.692	48.000	48.192
Cellulose Aceto-Buty-ate	7.7×10^{-6}	11.929	12.000	12.044	47.716	48.000	48.176
Cellulose Acetate	6.7×10^{-6}	11.938	12.000	12.038	47.752	48.000	48.152
Polystyrene	4.0×10^{-6}	11.963	12.000	12.023	47.852	48.000	48.092
Methyl Methacrylate	4.2×10^{-6}	11.961	12.000	12.024	47.844	48.000	48.096
Rigid Vinyl	7.0×10^{-6}	11.935	12.000	12.040	47.740	48.000	48.160
Polyethylene	9.4×10^{-6}	11.915	12.000	12.053	47.660	48.000	48.212
For Comparison							
Aluminum—2S	1.4×10^{-6}	11.987	12.000	12.008	47.948	48.000	48.032
Steel—1C	6.5×10^{-6}	11.994	12.000	12.004	47.976	48.000	48.016

*Normally stated in degrees C but converted here to degrees F for practical usage.
**Thermal coefficients for plastics are usually given as a range—we have used the average value in this chart; therefore, specific formulations of any given material may vary slightly from these figures.

and contraction to take place, without danger of either binding or expansion as the temperature rises, or of falling out on contraction as the temperature falls. Shipping and storage conditions, as well as actual use conditions, in determining the extreme temperature range, should be considered.

This greater expansion and contraction rate for plastics calls for another word of caution. Never fasten or tightly bind a plastic at *intermittent points* along its length. To do so will result in definite buckling between such points during expansion on temperature rise and, if the temperature remains high for an appreciable length of time, cold flow in the material may not permit it to return to its original shape during contraction on cooling. Free floating of the plastic section in the design should be allowed or, if it must be fastened tightly, do so adequately and over its full length.

Design Fundamentals

In designing, attempt to keep the section as "balanced" as possible across the cross section. If possible, keep to a uniform thickness; however, this is no longer a "must" due to improved molding and extrusion techniques. It does, however, have an important effect on extrusion or molding rate, therefore, cost. It also would result quite possibly in a shading or shadow effect in the section when lighted. For injection molded sections avoid undercuts or reverse curves since they result in costly molds. For extrusion, undercuts and reverse curves are feasible within reasonable limits.

Avoid sharp corners or grooves which cut too sharply or too deeply into the thickness of any section since these are structural weak points. If they are essential to attain the desired effect, then be certain the general thickness is adequate for strength and use fillets as generously as possible. It is most advisable to check the initial design with a reliable molder or extruder before making a final print of the section.

Do not design a section for "snap-in" unless the required bending of the section is very moderate and there is plenty of room for the section to return to its original shape after snapping into place. If a section is *held in place* by a "snap-in" fit, the strain applied to the section will develop internal stresses which may be sufficient to crack or break the section without any shock or it will be weakened to such an extent that a slight or moderate shock will crack or break it.

In designing the frame or chassis of a fixture incorporating plastic shielding or reflecting component parts, keep in mind the light weight of plastics since such can well afford economies in the cost of the steel or aluminum used as well as in later packing and shipping costs.

Since costs are virtually directly proportional to the weight of the plastic section, it is most important to determine the minimum thickness which can be used. However, in designing and engineering for a new plastic use, be certain that the specified thickness will *assure* the *full functional effect desired* and the *serviceability* required for the ultimate customer's complete satisfaction.

In summary, plastics can be used in fluorescent fixtures to contribute a far greater latitude for engineered lighting. This can be accomplished with complete safety through proper selection of the plastic material and proper design, consistent with the specific characteristics of the chosen plastic material. Close cooperation and mutual exchange of pertinent information and suggestions between fixture manufacturer and extruder or molder will obviate any possible trouble in actual service. In many cases, this close cooperation can result in appreciable economies in the finished fixture and provide better functional lighting.

Lighting a Jewelry Showroom

LIGHTING OBJECTIVE: To illuminate a jewelry sales area as an aid to quick sales and volume turnover of merchandise.

Installation at Jewelry Mart, 542 South Broadway, Los Angeles.

General Information: This 28 x 19 x 11 foot second floor sales area is decorated as follows:

Ceiling	white acoustical tile	60% RF
Walls	weathered oak	33% RF
Floor	mottled red-brown rubber tile	16% RF

Installation: Twelve louvered 4-foot fluorescent luminaires (Globe Lighting Products #KG 104-40), each with four 4500K lamps, and twelve 150-watt PAR-38 spot and floodlamp units* (Globe #SP-001) are mounted on the ceiling in a rectangular pattern.

The resultant illumination is as follows:

Center of room, 36 inches above floor	63 ft-c
Glass counter tops	
Under spotlamps	255 ft-c
Between reflector lamps	90 ft-c

Surface brightnesses measure:

Side walls	12 ft-L	Luminaire	
Floor	9 ft-L	Louvers at 30 degrees	550 ft-L
Ceiling	12 ft-L	Louvers at 45 degrees	800 ft-L
		Plastic side panels	600 ft-L

*Interchangeable for varied effect on merchandise displays.

Lighting data submitted by Illuminating Engineering Unit, Department of Water and Power, City of Los Angeles as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society
1860 Broadway, New York 23, N. Y.

Series XVI 12-51

A.I.A. File No. 31f

Annual Report of The General Secretary 1950-1951

A. H. MANWARING

THE CONSTITUTION of the Society specifies as one of the responsibilities of the General Secretary, the preparation of an annual report for publication in the Society's Transactions. This report, based on material received from the Society's officers, committees and Sections and Chapters, has been assembled with the assistance of headquarters. A preview of this annual report was presented at the National Technical Conference in Washington, D. C. on August 29th.

Membership

Statistics.—Table I of this report shows the Society's present membership in comparison with the figures for the past five years. These comparisons show a healthy increase in Member grade and a steady slow growth in Associate Membership. The total Student Membership has been seriously affected by the current defense efforts, but an increasing number, 56 this year, transferred over to Associate Member grade upon the conclusion of their schooling.

The gains and losses during the fiscal year and accounting for the general general increase in total membership from 7057 to 7166 are shown in Table II. It is heartening to report a considerable decrease in the loss of Members and Associate Members due to resignation, or dropping by Council for delinquency in dues payment.

Table III reports for the record the Society membership by Sections and Chapters, divided in each according to grade of membership. Certain of the local groups are to be congratulated for the high proportion of Members and Fellows among their membership.

Campaign.—The principal efforts toward increased membership were again put forth by the officers and membership committees of the 51 Sections and Chapters. These efforts were under the general direction of the National Membership Committee, James H. Hull, Chairman. Section and Chapter quotas were established on the same basis as the 1949-50 campaign, with a 20 per cent gain for total Associate Members and Members in Chapters less than three years old and a 12½ per cent gain for Sections and Chapters over three years old. Prize money was equally divided between the total new members, and Member grade part of the campaign. Prize winners in the two parts of the campaign, with the respective local Membership Chairmen are as follows:

Total Membership

First—Northwestern Ohio Chapter, M. L. Bettinger

Second—Milwaukee Section, Howard Grosh

Third—Chicago Section, D. William Fuller

Member Grade

First—Rocky Mountain Section, James L. Vanneman

Tie—San Jacinto Section, Warren W. Williamson

Second—British Columbia Section, Eric E. Ackland

Tie—Northwestern Ohio Chapter, M. L. Bettinger

Third—Tennessee Valley Chapter, William B. Taylor

There has been comment from time to time as to the method used in establishing quotas for the membership campaign. In this connection it is interesting to note that over half of the Society's 51 local groups have been established since 1940. It is therefore natural that the large part of the Society's growth will continue to be in the younger Chapters.

Members Emeritus.—Two Fellows were elected to the grade of Member Emeritus during the fiscal year having retired from regular occupation after having performed for the Society services of such meritorious character as the Council deemed worthy of this honorable award. They are: E. C. Crittenden and Richard E. Simpson.

TABLE I.—Membership as of September 30.

	1946	1947	1948	1949	1950	1951
Members Emeritus	16	16	21**	26***	33****	32*****
Fellows	21	42	45	44	40	42
Members	986	1,201	1,406	1,521	1,610	1,709
Associate Members	3,878	4,335	4,908	5,048	5,005	5,174
Student Members	45	71	136	244	369	209
Total	4,946	5,665	6,516	6,883	7,057	7,166
*Wartime Dues Waived	220*	.....	.....	.....	.....	.....

*These members are included in the Total.
Fellows of the Society included **3, ***5, ****9, *****10.

TABLE II.—Gains and Losses in Membership During Year Ending September 30, 1951.

	Members Emeritus	Fellows	Members	Associate Members	Student Members	Total
October 1, 1950	32	41	1610	5005	369	7057
Gains						
Elections	0	0	71	743	127	941
Reinstatements	0	0	15	95	24	134
Transfers	3	4	74	56	0	137
Total Gains	3	4	160	894	151	1,212
Losses						
Resignations	0	0	25	320	255	600
Dropped	0	0	20	302	0	322
Deceased	3	0	12	29	0	44
Transfers	0	3	4	74	56	137
Total Losses	3	3	61	725	311	1,103
Net Change	0	+1	+99	+196	—160	+109
Total Membership as of September 30, 1951	32	42	1,709	5,174	209	7,166

A report presented at the National Technical Conference of the Illuminating Engineering Society, Washington, D. C., August 27-30.

Deceased.—The Society records with sorrow the death of 3 Members Emeritus, 12 Members and 29 Associate Members during the year.

Members Emeritus

Hobbie, Edward H. Hanson, Frank A. Young, P. S.

Members

Bird, Charles W. Brady, Ralph R. Fowler, Earl W. Hills, Donald A. Hughes, Richard J. Krone, Glenn Mark, Isaac, Jr. Ryan, John P., Jr. Staud, Rudolf W. Taylor, R. A. Uhlenhaut, Fritz Waldo, Edward H.

Associate Members

Adams, Milton K. Callaway, L. H. Contier, Ernest J. Davies, W. E. Dennis, Vernon E. Detweiler, Paul G. Emerson, Frank E. Hahn, Louis H. Harris, Beula H. Heatley, H. M. Herb, Lester A. Howze, W. D. Jones, E. C. Kable, George W. Krause, E. E. Landreth, C. P. Navarre, Thomas J. O'Brien, Stephen J. Reynolds, Edward F. Smeaton, H. A. Snyder, Chester Spinney, L. B. Van Allen, Melvin H. Warner, Harry O. Wayne, Arthur Westerberg, Oliver D. Widdowfield, Donald Y. Wilson, Herbert W. Wooster, L. F.

Local Activities

Sections, Chapters, Branches.—The approval of a Charter for the Mexico Chapter at the October Council meeting brought the total of the Society's local groups to 51 Sections and Chapters and 4 Student Branches. Built around the enthusiastic interest of a group of members, and the activities of the Lighting Institute at Mexico City, the new Chapter received its Charter from the President on March 7.

The reports from the local groups give a picture of a year of solid achievement with a number of successful special activities. Among them were a number of competitions involving presentations by members of "My Most Interesting Job." For this activity the Local Activities Committee provided a special set of points for use as a rating scale.

Continued interest expressed by the local groups resulted in Council action to authorize the engrossing of certificates expressing the Society's appreciation for the services of the Section and Chapter Chairmen. Such certificates were made available to all local groups toward the end of the active year and were well received.

Sections.—Although no new Chapters were chartered during the year, two of the existing Chapters successfully petitioned for transfer to Section status, having demonstrated that they met the constitutional requirement of membership and years of effective operation. They are:

Milwaukee Section, October 12, 1950, established as a Chapter February 1946.

Central New York Section, June 14, 1951, established as a Chapter June 1944.

During the year the subject of transfer of Chapters to Section status was discussed at several committee meetings. Agreement was reached that it was desirable for Chapters to petition for the recognition in this more mature status after operating effectively for

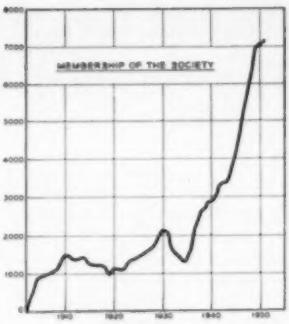

Figure 1.

TABLE III.—Membership of Sections and Chapters as of September 30, 1951.

	Members Emeritus	Fellows	Members	Associate Members	Student Members	Total
CANADIAN REGION						
Hamilton, Ontario Chapter	0	1	8	33	0	42
Maritime Chapter	0	0	8	27	0	35
Montreal Section	0	0	34	88	1	123
Ottawa Chapter	0	0	11	22	0	33
Quebec Chapter	0	0	11	48	0	59
Toronto Section	1 (1F)	1	40	132	2	176
Winnipeg Chapter	0	0	10	49	1	60
EAST CENTRAL REGION						
Baltimore Chapter	0	0	17	53	0	70
Capital Section	2 (1F)	2	39	67	0	110
Eastern Pennsylvania Chapter	1	0	49	115	1	166
Philadelphia Section	2 (1F)	2	82	191	7	284
Pittsburgh Section	0	0	52	148	1	201
GREAT LAKES REGION						
Central New York Section	1 (1F)	0	19	76	2	98
Cleveland Section	3 (2F)	11	103	211	26	354
Michigan Section	1	1	57	184	0	243
Northwestern Ohio Chapter	0	0	15	58	0	73
Ohio Valley Section	1	0	40	98	5	139
Rochester Chapter	0	0	9	63	0	72
Western Michigan Chapter	1 (1F)	0	18	50	0	69
Western New York Section	0	1	9	55	2	67
MIDWESTERN REGION						
Chicago Section	3 (1F)	3	135	411	34	586
Cornhusker Chapter	0	0	11	60	0	71
Heart of America Section	0	0	34	89	7	130
Indiana Chapter	0	0	17	87	2	106
Iowa Section	0	0	18	76	4	98
Milwaukee Section	0	1	25	132	9	167
St. Louis Section	0	0	24	101	0	125
Twin City Section	0	0	26	140	3	169
NORTHEASTERN REGION						
Connecticut Section	3 (1F)	1	33	101	0	138
New England Section	1	6	76	252	1	336
New York Section	7 (1F)	6	172	350	17	552
PACIFIC NORTHWESTERN REGION						
British Columbia Section	0	0	18	71	0	89
Inland Empire Chapter	0	0	6	42	1	49
Oregon Section	1	0	22	72	27	122
Puget Sound Section	0	0	18	80	1	99
SOUTHERN REGION						
Carolinas Chapter	0	0	29	80	0	109
Florida Chapter	1	0	20	64	0	85
Georgia Section	0	0	45	107	1	153
Mississippi Chapter	0	0	7	32	11	50
New Orleans Section	0	0	17	63	0	80
Southeast Florida Chapter	0	0	13	46	0	59
Tennessee Valley Chapter	0	0	22	73	13	108
SOUTH PACIFIC COAST REGION						
Mother Lode Chapter	0	0	12	30	0	42
Northern California Section	1	2	49	169	12	233
Southern California Section	1	2	83	186	9	281
Utah Chapter	0	0	18	30	0	48
SOUTHWESTERN REGION						
Alamo Chapter	0	2	14	41	0	57
Rocky Mountain Section	0	0	20	67	2	89
San Jacinto Section	0	0	15	54	2	71
Southwestern Section	0	0	39	141	2	182
Foreign Non-Section	1	0	33	148	3	185
Mexico Chapter	0	0	7	16	0	23
TOTAL	32*	42	1,709	5,174	209	7,166

*Includes 10 Fellows of the Society.

at least three years and achieving the required count of membership.

Regional Conferences. — Particularly successful Regional Conferences were held in seven of the Regions with President Sturrock in attendance at each to make a Presidential Address. These conferences have grown so successfully and have held such effective technical sessions, that they take on the aspect of the sessions in a National Technical Conference of the Society. Several Regional Vice-Presidents used the occasion of the conferences to schedule discussions of local activities and included in these gatherings the local representatives in the Region. An especially valuable conference on local activities was held in conjunction with the Canadian Regional Conference. Regional and local officers cooperated perfectly in planning 1951-52 Regional Conferences, and by the time of the June Council meeting all of these had been set definitely as to date and location.

Regional Conferences held during 1950-51 were as follows:

October 26-27 — Northeastern — New York N. Y.

March 4-6 — Southwestern — Corpus Christi, Texas

March 22-23 — Pacific Northwest — Spokane, Washington

April 9-10 — Southern — Miami Beach, Florida

May 9-12 — Canadian — Quebec City, Que., Canada

May 18-19 — Midwestern — Des Moines, Iowa

May 24-25 — Great Lakes — Cincinnati, Ohio

Potential New Chapters. — The Local Activities Committee gave consideration early in the fiscal year to a number of areas which seemed to offer good possibilities for the establishment of new Chapters. Local representatives were appointed in many of these locations and several showed definite signs of growth and organization during the year.

Local Representatives.—Upon nomination by the Regional Vice-Presidents the appointment of a total of 225 local representatives was confirmed by Council this year. These members provided representation of the Society in localities remote from the headquarters city of the 51 local groups. The work of many local representatives was integrated with the extension program of the nearby Section or Chapter. In four instances the local representatives served as Faculty Adviser to the Student Branches of the Society.

TABLE IV.—Meetings of Sections and Chapters for Year Ending September 30, 1951.

	Number of Meetings	Total Attendance	Average Attendance
CANADIAN REGION			
Hamilton, Ontario Chapter	7	280	40
Maritime Chapter	8	190	23
Montreal Section	9	456	50
Ottawa Chapter	8	223	27
Quebec Chapter	9	205	22
Toronto Section	7	470	67
Winnipeg Chapter	9	553	61
EAST CENTRAL REGION			
Baltimore Chapter	8	1,394	174
Capital Section	8	301	37
Eastern Pennsylvania Chapter	8	943	117
Philadelphia Section	6	659	109
Pittsburgh Section	7	531	75
GREAT LAKES REGION			
Central New York Section	8	379	47
Cleveland Section	6	659	109
Michigan Section	9	1,066	118
Northwestern Ohio Chapter	7	433	61
Ohio Valley Section	6	1,561	260
Rochester Chapter	9	512	56
Western Michigan Chapter	8	494	61
Western New York Section	7	204	29
MIDWESTERN REGION			
Chicago Section	10	1,972	197
Cornhusker Chapter	2	114	57
Heart of America Section	8	426	53
Indiana Chapter	9	527	58
Iowa Section	3	231	77
Milwaukee Section	9	728	80
St. Louis Section	10	576	57
Twin City Section	8	633	79
NORTHEASTERN REGION			
Connecticut Section	8	412	51
New England Section	7	795	113
New York Section	7	602	86
PACIFIC NORTHWESTERN REGION			
British Columbia Section	9	409	45
Inland Empire Chapter	7	238	34
Oregon Section	9	327	36
Puget Sound Section	9	271	30
SOUTHERN REGION			
Carolinas Chapter	7	485	69
Florida Chapter	5	354	70
Georgia Section	9	615	68
Mississippi Chapter	9	220	24
New Orleans Section	8	511	63
Southeast Florida Chapter	7	222	31
Tennessee Valley Chapter	8	318	39
SOUTH PACIFIC COAST REGION			
Mother Lode Chapter	8	195	24
Northern California Section	9	453	50
Southern California Section	9	1,163	129
Utah Chapter	7	205	29
SOUTHWESTERN REGION			
Alamo Chapter	8	151	18
Rocky Mountain Section	7	390	55
San Jacinto Section	8	179	22
Southwestern Section	8	325	40
Mexico Chapter	5	103	20
GRAND TOTAL—SECTIONS AND CHAPTERS	391	25,663	65

Committee Meetings.—Under the chairmanship of Vice-President E. M. Strong, the Committee on Local Activities, which includes all nine Regional Vice-Presidents, held a series of important meetings this year for the discussion of local activities. Discussion included such subjects as new Chapter prospects, the organization of local representatives, Section and Chapter finances and the planning of 1951-52 Regional Conferences. The committee meeting held June 13 in conjunction with Council, was devoted to a training program for the Regional officers, and through them to the Section and Chapter officers. Specific accomplishment was also achieved in the revision of the Guide for Regional Vice-Presidents and the Guide for the Operation of Regional Conferences.

Student Branches

University of Cincinnati—Russell J. Dickason, Faculty Adviser. The activities of this Branch were brought to a standstill by Mr. Dickason's transfer of work from the University to em-

ployment in industry. Pending re-activation of the Branch, the Charter is in the keeping of the officers of the Ohio Valley Section.

Mississippi State College—Robert S. Wiseman, Faculty Adviser. The Branch held a full program of activity throughout the year including attendance by delegations to the President's Night dinner meeting of the Mississippi Chapter, and the Southern Regional Conference at Miami Beach.

University of Illinois—J. O. Kraehenbuehl, Faculty Adviser. Seven Branch meetings were held during the nine months of the academic year. In addition to organizing these professional meetings the Branch actively participated in campus affairs.

City College, New York—Abraham Abramowitz, Faculty Adviser. The program of the Branch included some 20 business meetings, with four speakers on subjects in illuminating engineering, and one field trip. Special projects of the Branch included a Lighting Survey of the School Library and a Job Survey in the lighting field.

Representatives to Other Organizations

During the year the Society maintained relations with other associations and agencies in the fields of science and standardization; through the appointment of official representatives. These included 19 members of the Society on 18 Sectional Committees of the American Standards Association with C. L. Crouch, Technical Director, serving in each case as an ex-officio member. Official representatives were also appointed to the following:

Armed Services N.R.C. Vision Committee
Exploratory Group to Consider Increased Unity of the Engineering Profession
Industry Committee in Connection with the Revision of "Handbook of Interior Wiring Design"
Institute of Traffic Engineers, Joint Committee on Highway Lighting
Inter-Society Color Council
National Committee on Traffic Safety
National Committee on Uniform Traffic Laws and Ordinances
National Engineering Advisory Committee
National Office Management Association, Committee on Physical and Physiological Factors
National Research Council, Division of Engineering and Industrial Research
National Research Council, Highway Research Board
National Research Council, National Academy of Sciences
President's Highway Safety Conference
Society of Motion Picture and Television Engineers
U. S. National Committee of the International Commission on Illumination

I.E.S. Research Fund

(Extract from the Annual Report for the Year Ending December 31, 1950, presented to Council, April 1951.)

Board of Trustees.—During the year the following men served as members of the Board (with terms of office noted):

Anthony W. Deller	To October 20, 1954
Conrad Berens	To October 20, 1953
A. F. Wakefield	To October 20, 1952
J. W. Barker	To October 20, 1951
A. F. Nicoll*	To October 20, 1950

*Re-elected to term of 5 years at Trustees meeting, October 26, 1950.

and Presidents of the Society (term of 2 years)

Walter Sturrock**	To September 30, 1952
C. H. Goddard	To September 30, 1951
L. E. Tayler	To September 30, 1950

**Took office as of October 1, 1950.

The Board received final reports from the Research Executive Committee on the completed projects as follows:

"The Effect of Task Brightness to Surround Brightness Ratios on Visual Performance"—Prof. R. L. Biesele, Jr., Southern Methodist University (Project #18).
"Visibility Test Methods"—Prof. C. L. Cottrell, Cornell University (Project #19).
"Munsell Reference Colors Now Specified for Nine Illuminants"—Dorothy Nickerson and Davis Wilson.
"Muscle Action Potentials as a Measure of Visual Performance Cost"—Dr. John L. Kennedy, Tufts College (Project #23).

These were approved for transmittal to the Society's Papers Committee (Projects #18 and #19) and to the Publications Committee (Project #23). The first three reports mentioned above have been published in ILLUMINATING ENGINEERING (Vol. XLV, No. 12, December 1950; Vol. XLVI, No. 2, February 1951; and Vol. XLV, No. 8, August 1950, respectively).

Upon recommendation of the Research Executive Committee the Board balloted favorably on Project #30, "Investigation of Comparative Detection and Resolution Thresholds of the Eye" by Dr. H. Richard Blackwell, Vision Research Laboratory, University of Michigan.

The Board balloted favorably on the Wakefield Plan for promoting lighting research other than by complete sponsorship through the solicitation of cooperation by Research Foundations and Agencies. This work is being carried on by H. M. Sharp and an interim report has been submitted.

Some of the business was conducted by mail and the annual meeting was held October 26, 1950, for the election of officers, the detailed consideration of progress, and the approval of a new budget. Chairman Wakefield and Treasurer Nicoll have diligently followed the work and finances respectively.

Research Executive Committee.—The Research Executive Committee held two meetings (April and September) for detailed consideration of progress and action on proposals and reports. Considerable work was carried on by correspondence.

The Committee considered 8 proposals recommending one for contract, two for cooperative counseling, and rejected five. Project #30 was recommended to the Trustees for contract.

Final reports were received for processing from the Technical Advisory Committees on the following projects:

"Verification of Interreflection Formulae"—Prof. H. S. Bull, University of Michigan (Project #4).
"Measurement of Work Done by Extrinsic Ocular Muscles"—Parry Moon and K. S. Lion, Massachusetts Institute of Technology (Project #5).
"Spatial and Temporal Characteristics of Retinal Inhibition"—Dr. Glenn A. Fry, Ohio State University (Project #17).
"The Effect of Task Brightness to Surround Brightness Ratios on Visual Performance"—Prof. R. L. Biesele, Jr., Southern Methodist University (Project #18).
"Visibility Test Methods"—Prof. C. L. Cottrell, Cornell University (Project #19).
"Muscle Action Potentials as a Measure of Visual Performance Cost"—Dr. John L. Kennedy, Tufts College (Project #23).

Reports on Projects #18, #19, and #23 have been passed on to the Trustees for favorable approval. Those for Projects #4, #5, and #17 are in processing channels.

Chairman Harrison actively followed the progress of each project and counselled with those having more difficult problems. The other members of the Research Executive Committee serving during the year were: Ralph M. Evans, G. R. Harrison, J. O. Kraehenbuehl, Howard M. Sharp, R. M. Zabel.

Standing Committees

Council Executive

Walter Sturrock, Chairman

The careful study of many details regarding the activities of our Society and subsequent actions taken by this committee not only greatly expedited the required work of the Council but also appreciably conserved its time. This made it possible to complete in a single day the agenda for each of the

five regular Council meetings. In general, the Executive Committee acted in an advisory capacity and particularly on matters which did not require formal action. All matters, however, were reported at the next meeting of the Council for their records and further comment.

Finance

M. N. Waterman, Chairman

Pension Plan. — The committee started the year with a legacy of the excellent plan developed during the previous year. The plan, as approved by Council, has become effective with all eligible Society employees participating. The value to the Society through its headquarters staff is believed to be very worth while in relation to the annual cost of the Society of some $3,000 to $5,000.

Unused Balances in Section and Chapter Treasuries.—Studies of year-end balances in Section and Chapter treasuries (from allotments out of national funds) showed a total of about $4,000 to the end of 1949-50. The committee noted this unused balance when reporting to Council in October and urged consideration of means by which Sections and Chapters might get maximum benefit from this "idle" money. At Council's instruction a letter was sent to all Chapters (not Sections) calling attention to the desirability of activities justifying full use of allotted national funds. The committee believes this question of full use of allotments deserves continued study next year.

Financing of IES Lighting Handbook.—Aided by budget estimates furnished by the Publications Committee, Handbok Revision Committee and Technical Director's office, the committee recommended a budget program to Council and found it possible to finance the preparation of the Handbook from current funds during this year.

Financing the Move of Headquarters Office. — It has been possible to finance the outlay of about $7,800 from cash balances. The cost will be charged off at rate of 1/5 each year for the five years covered by our lease. Thus the cost of moving, lighting and decorating becomes for five years an added operating expense of about $1,560 per year.

Future Item.—The committee has asked the cooperation of Sections and Chapters in submitting detailed budget

Statement of Income and Expense for the Year Ended September 30, 1951.

Income		
Annual Dues:		
Members	21,539.25	
Associate Members	53,945.96	
Student Members	613.00	
Fellows	704.00	
Entrance Fees	2,120.00	78,922.21
Sustaining Members		40,793.33
Sales, Publications, Gross Income		
IES Lighting Handbook	3,998.80	
Lighting Data Sheets, Binders	1,913.81	
Reprints	10,314.30	
ILLUMINATING ENGINEERING	9,281.40	
National Technical Conference Preprints	345.87	
Membership Roster	338.75	26,192.93
ILLUMINATING ENGINEERING, Advertising		62,792.78
Sales, Badges and Certificates, Gross Income		526.95
Interest		
Investments	643.00	
Bank Balances	27.37	670.37
1951 National Technical Conference Income	12,126.67	
Less: Expense	10,917.02	1,209.65
Income from Motion Picture		34.00
Total Income		211,142.22
Expense		
General		1,863.78
Office, Business	41,648.68	
Office, Technical	15,984.19**	
Office, Publications	28,423.39***	86,056.26
Organization, Committees	716.14	
Regional	15.00	
Sections and Chapters	16,473.06	
President's Travel	2,000.00	19,204.20
Sales, Badges and Certificates, Cost of Stock		542.77
Depreciation, Furniture and Fixtures	500.00	
Publications Stock	724.69	1,224.69
ILLUMINATING ENGINEERING, to members		43,472.95
Sales, Publications, Cost of Stock		
IES Lighting Handbook	1,355.94	
Lighting Data Sheets, Binders	675.92	
Reprints	4,349.26	
ILLUMINATING ENGINEERING	4,993.13	
National Technical Conference Preprints	224.11	
Membership Roster	176.57	
Sales, Publications, Cost of Services, Promotion	5,422.49	17,197.42
Retirement Pension Plan		3,047.17
Federal Social Security Tax		503.24
Total Expense		173,112.48
NET INCOME		38,029.74

**1950-51 Actual 28,855.99 less deferred charge to Handbook Revision—12,871.80.
***1950-51 Actual 30,923.39 less deferred charge to Handbook Revision— 2,500.00.

Comparison of Income and Expense for the Past Three Years.

	1948-1949	1949-1950	1950-1951
Income			
DUES			
Fellows	645.00	720.00	704.00
Members	17,842.00	20,261.75	21,539.25
Associate Members	48,293.62	52,357.25	53,945.96
Student Members	740.50	1,100.00	613.00
Entrance Fees	2,445.00	2,065.00	2,120.00
Sustaining Members	40,335.00	40,535.00	40,793.33
SALES			
Publications Gross	30,938.82	31,122.38	26,192.93
I. E. Advertising	47,672.24	56,494.78	62,792.78
Badges and Certificates	520.50	276.41	526.95
INTEREST	666.07	618.46	670.37
CONFERENCE, Net Income	109.23	467.33	1,209.65
INCOME FROM MOTION PICTURE			34.00
TOTAL INCOME	190,207.98	206,018.36	211,142.22
Expense			
GENERAL	1,090.25	1,206.87	1,863.78
OFFICE			
Business	43,181.27	44,135.87	41,648.68
Technical	20,925.88	21,846.37*	15,984.19**
Publications	33,174.71	32,685.79	28,423.39***
ORGANIZATION			
Committees	1,951.47	1,656.00	716.14
Regional	498.22	138.09	15.00
Sections and Chapters	13,746.38	15,368.06	16,473.06
President's Travel	2,000.00	2,000.00	2,000.00
SALES, Badges and Certificates	324.12	213.35	542.77
Depreciation	745.41	1,002.52	1,224.68
ILLUMINATING ENGINEERING to Members	40,792.63	45,452.60	43,472.95
Sales, Publications, Cost of Stock, Services	20,609.93	22,590.32	17,197.42
Retirement Pension Plan			3,047.17
Federal Social Security Tax			503.24
TOTAL EXPENSE	179,040.27	188,295.84	173,112.48
NET INCOME	11,167.71	17,722.52	38,029.74

*1949-50 Actual 26,783.97, less deferred charge to Handbook Revision 4,937.60.
**1950-51 Actual 28,855.99, less deferred charge to Handbook Revision 12,871.80.
***1950-51 Actual 30,923.39, less deferred charge to Handbook Revision 2,500.00.

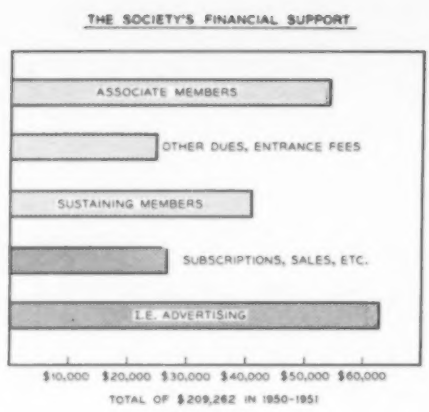

Figure 2.

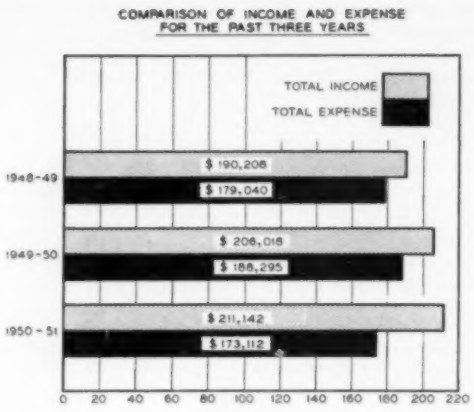

Figure 3.

requests for 1951-52 year. The committee will review the data for the purpose of appraising present procedure and the "standard formula." The objective is to achieve recommendations for allotments which are up to date with respect to current and proposed activities of our expanded number of Sections, Chapters and members.

With sincere thanks to Mr. Hinckley and the headquarters office who provided financial data most efficiently and also to the Committee, C. C. Keller, George Taylor and R. F. Hartenstein, Treasurer, for participation and counsel.

General Board of Examiners

E. M. Fahey, Chairman

The General Board of Examiners met monthly throughout the year and carefully examined the applications of all desiring election to Member grade and all proposed for election to the grade of Member Emeritus.

The Board also reviewed resignations from the Society in order that any who might merit the grade of Member Emeritus would not be allowed to leave the Society without proper recognition.

A review of the paragraphs descriptive of Member grade qualifications has been made with recommendations for changes within the limits of the present constitutional requirements.

Board of Fellows

H. M. Sharp, Chairman

The Board reviewed all nominations on file together with a number of new nominations submitted in the current year. A recommendation as to the election of one Member to Fellow grade was submitted for action of Council toward the end of the fiscal year. The Board also submitted to Council some suggested improvements in the procedure under which the Board operates. These were referred by Council to the Committee on Procedures and Policies for review and report.

Medal Award

G. W. Beals, Chairman

The Award Committee, operating under approved procedures, held one regular meeting at which five members were present, and the four absentee members each reported by letter his decisions and comments on the affairs of the Committee. No names of new candidates had been formally brought before the Committee for consideration together with names carried over from the preceding year. The decision of the Committee was that "No medal award be made in 1951."

The Committee then prepared a recommendation to Council for a revision of the present procedure governing the Medal Award activity. The proposed revisions were intended to stimulate greater participation in this activity by simplifying the nomination procedure, and arranging for the preparation of complete, uniform, and impartial records of candidates by personnel with experience and facilities for such work. The proposed amendment is now under consideration by the Procedures and Policies Committee.

Balance Sheet — September 30, 1951.

Assets

Cash in Banks		23,588.70
Petty Cash Fund		300.00
Accounts Receivable		11,183.82
Due from 1951 Conference Committee		635.08
Investments (Cost)	20,675.25	
Accrued Increment—U. S. Savings Bonds	983.50	21,658.75
Inventories		10,785.02
Furniture and Fixtures	12,069.55	
Less: Reserve for Depreciation	7,051.66	5,017.89
Deferred Charges to Expense of 1951-52		
Sections and Chapters	4,389.42	
ILLUMINATING ENGINEERING	8,928.88	
Handbook Revision Costs—Net	17,248.62	
General Office Expense	5,410.10	
Moving Expense	7,872.70	43,849.72
Accrued Interest on Investments		67.06
Total Assets		117,086.04

Liabilities and Surplus

Liabilities		
Accounts Payable		2,154.06
Deferred Income		
Dues Received in Advance	1,097.29	
Subscriptions Received in Advance	3,285.00	
Conference Preprints	475.50	4,857.79
Surplus		110,074.19
Total Liabilities and Surplus		117,086.04

Papers

Hoyt P. Steele, Chairman

The Committee devoted its entire attention to the planning of the papers sessions for the Washington National Technical Conference, selecting and instructing members to serve as session chairmen and discussion organizers. The Committee succeeded in reviewing 45 for presentation at the Conference of which 42 were submitted in time for preprinting.

Publications

E. C. Huerkamp, Chairman

ILLUMINATING ENGINEERING. — On the basis of reader reaction, response from advertisers, and demand for reprints, good progress was made during the past year by the Society's journal, toward its objective of providing a monthly publication widely representative of both the science and art of illumination, and the presentation of current good lighting practice. Twelve issues were published, two of which were "special" issues featuring, in May 1951 a comprehensive symposium on Industrial Lighting, and in September 1951, complete abstracts of the papers presented at the National Technical Conference. Reader response to these symposiums was gratifyingly favorable.

Policy on editorial content was revised, in this past year, to the extent that not all of the Pasadena Conference papers were published in full in ILLUMINATING ENGINEERING. Some 28 were published in several issues immediately following the Conference in full, together with discussion and rebuttal. The omission of ten Conference papers, considered by the Papers Committee and the Publications Committee to be adequately presented in the September 1950 Abstract, released more pages for application articles on current lighting practice. The new policy was in line with the expanded journal's objective of providing practical lighting data of wide interest, as well as technical reports and papers on illuminating engineering developments. The resulting increase in practical application material, attractively presented, met with wide approval. The attached table presents a break-down of page content by subject matter.

Preprints and Conference Proceedings.—Preprints of all 1951 National Technical Conference papers were published for distribution to delegates at the Conference, and for use by potential discussors. Full sets of Conference preprints were also bound in a special cover to be available as "Conference Proceedings" for sale to members at a nominal price.

Membership Roster.—At the direction of Council to make available an up-to-date business directory of membership, "to be produced on a self-liquidating basis," compilation of such a directory was undertaken by the Publications Committee, last Spring. Printed copies were made available, the production costs of which are to be liquidated by their sale at $2.00 per copy.

IES Lighting Handbook.—The production of the revised Second Edition of the Lighting Handbook was a major publications project during 1950-1951. The Committee presented a carefully prepared budget of production and sales of the book, and has directed all production details of its publication.

Advertising and Promotion. — The expanded distribution program for all Society publications, including the official publication, ILLUMINATING ENGINEERING, has continued at the good rate of development started in January 1949. During the 1950-51 Society year to date, exclusive of subscriptions to Lighting Data Sheets and ILLUMINATING ENGINEERING, 30,531 copies of Society publications, including reprints of published articles, have been distributed to organizations and individuals with every degree of lighting interest in all parts of the world. This represents a rate of nearly 3,400 publications per month. This program has been accomplished in a great measure by an increasing degree of cooperation from Sections and Chapters in keeping their membership informed of new publications and reminded of others regularly. In addition, advertisements in ILLUMINATING ENGINEERING, announcements in related publications, and frequent direct mail efforts have contributed.

Several Society publications have enjoyed particularly widespread distribution this year. "Contemporary Lighting in Modern and Traditional Interiors," latest report of the Residence Lighting Committee, has been very popular. Over 5,000 copies of this report have already been distributed, and we have ordered well into the second run of 5,000. Because of the importance of the May 1951 "Industrial Lighting" issue of ILLUMINATING ENGINEERING, which carried the new proposed American Standard Practice for Industrial Lighting and featured

COST OF THE SOCIETY'S SERVICES

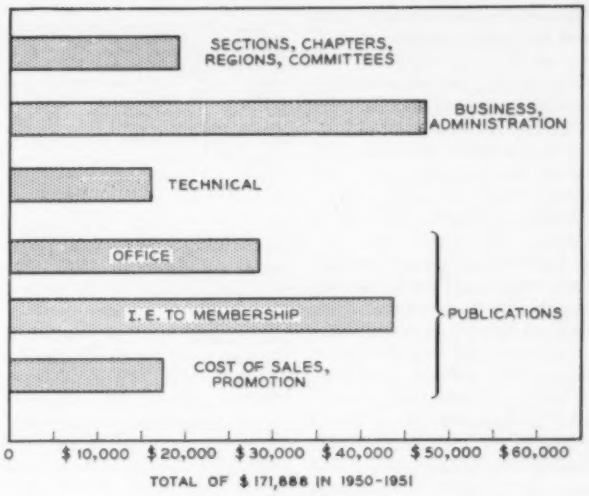

Figure 4.

throughout, lighting for defense plants, nearly 1,000 copies of the issue over and above the regular circulation were ordered by public utilities, manufacturers and others.

The production and initial distribution of the new Second Edition of the *IES Lighting Handbook* has been one of the major publication efforts this year. A comprehensive direct mail program, offering a special price on pre-publication orders has resulted in the ordering of 5,000 or more copies by members and non-members, guaranteeing a substantial distribution upon publication. These purchasers include architects, consulting engineers, building engineers and superintendents, electrical contractors and wholesalers, manufacturers, government engineers, etc. In all probability the new book will replace the First Edition as a lighting textbook in many engineering schools and colleges. The promotion program for advertising in the Manufacturers' Reference Data section of the new Handbook resulted in the sale of 170 pages to 85 advertisers with a net income receivable well over the amount budgeted.

ILLUMINATING ENGINEERING, the Society's official monthly publication, has continued to develop as planned during 1950-51. Along with the expansion of the editorial content to include practical articles on lighting application and technique as well as technical and theoretical material, the advertising section has expanded and become more informative and useful in its nature. The list of advertisers exceeds 100 and includes the names of the leading companies in the manufacture of lighting equipment of all description. Any increase in Society membership is, of course, reflected in increased circulation of the publication. However, in addition to increased member circulation, there is a marked increase in the number of non-member subscriptions, a definite indication of the broadening influence and interest in lighting being generated by this effort.

TABLE V.—Illuminating Engineering Page Content by Subject Matter.

	Oct. 1949 to Sept. 1950	Oct. 1950 to Sept. 1951
Technical Conference Papers, Including Discussions and Abstracts	176	260
Technical Committee Reports	144	105
Other Papers, Articles and Reports	216	254
Lighting Data Sheets	35	42
Editorials	3	3
Telecast including Current News, etc.	119	93
List of Officers, Committees, Sustaining Members	42	30
Advertising	256	283
Total Pages Published	991	1,070

General Committees

Board of Nomination

R. W. Stand, Chairman

Operating under procedures specified in the Constitution and By-Laws the appointment of the Board was initiated at the October Council meeting by the selection of the three past-presidents and the chairman of the Board. The appointment of the representatives by the respective Sections was accomplished and the Board held its meeting for the slate of national officers in February. Extensive records of active members and previous officers of the Society were prepared and circulated to the whole Board for their study in connection with the selection of the slate.

Constitution and By-Laws

G. K. Hardaere, Chairman

Throughout the year actions of the Council related to Society Constitution and By-Law provisions were carefully studied. After the required acceptance by Council letter ballot of Constitution and By-Law Committee report, the amendments to the Constitution were submitted for referendum vote by the membership. These Constitutional changes, as approved by the membership, together with By-Law revisions approved by Council, as appearing in item 134 of Council Minutes, follow:

Approved Revision By-Law in Article II—Membership

(a) *Sec. 1:* The following abbreviations may be used by members of the respective classes in indicating their membership in the Society. It is recommended, however, that insofar as possible abbreviations of membership grades be avoided:

Associate Members	A. I.E.S.
Members	M. I.E.S.
Fellows	F. I.E.S.

Approved Revision Section 2, Article IV—Dues

Section 2: The annual dues for Associate Members shall be $13.50; for Members $15.00, and for Fellows $15.00. Annual dues for Student Members shall be 5.00. These dues shall include one subscription to the designated official publication of the Society.

Approved Revision By-Law in Article VII—Management

(b) *Sec. 11:* To provide for security and continued operations of Society activities, it shall be the aim and policy of the Society to develop and maintain a minimum reserve, in cash and negotiable securities, equal to twenty-five per cent of current total budgeted annual expenses. Whenever, at the beginning of any fiscal year, the reserve shall be less than this figure, the Committee on Finance, in preparing the budget shall, if practicable, include a sum for reserve equivalent to five per cent of the proposed budget.

Defense Coordinating

A. F. Wakefield,

G. D. Mills, Co-Chairmen

The Committee has more than been reactivated by the Korean Affair. Its earlier progress has been reported by an article in the July 1951 issue of ILLUMINATING ENGINEERING. At the present time the Committee is coordinating a research project for the Corps of Engineers; membership on National Research Council; a new technical Committee on National Civilian Light Control; a Collation Task for Research and Development Board; promotion of a research for Psychological Warfare and another for the Bureau of Ships, U. S. Navy, along with sponsoring the Tuesday evening Session on Military and Civil Defense Lighting for the National Technical Conference in Washington.

Historical

S. G. Hibben, Chairman

By correspondence this Committee has nearly completed an historical record of the founding of the Society and its operations during its first decade. An effort was made to trace the origin and meaning of the official badge or design of pin and it is expected to soon record officially this information. A plan was started to obtain voice recordings of the elder past-presidents, four of whom have offered drafts of texts and one recording completed. After completion of the new offices, it is proposed to enlarge the Illumination Library and any historical documents of special value.

Lighting Service

L. E. Tayler, Chairman

The Committee reviewed the programs of the Lighting Service Forums held in recent years, in conjunction with the National Technical Conferences of the Society, and found that these have demonstrated such important factors in reaching the changing lighting market, as the Planned Lighting Program, together with examples of application to electric utilities and the lighting industry. This year's Committee then developed a novel vehicle whereby an inventory of accomplishment can be taken, in the Forum scheduled on the opening evening of the National Technical Conference in Washington, D. C.

Local Activities

E. M. Strong, Chairman

The work of this committee is outlined in the preliminary pages of this report.

Membership

James H. Hull, Chairman

The work of this committee is outlined in the preliminary pages of this report.

National Technical Conference

R. F. Hartenstein, Chairman

The final report of the Southern California Conference was presented at the December 1950 meeting of Council, revealing that the Conference was self-supporting; in fact there was a surplus after all bills were paid; many favorable comments were received regarding the success of the Conference; that all committees performed excellently and were complimented on a job well done. The Committee cooperated with the Conference Executive Committee, the Papers and Publications Committee in planning the 1951 Conference in Washington, D. C.

Council, at its February meeting, approved the recommendation of the New York Section and this Committee that the 1953 Conference be held at the Commodore Hotel in New York, September 14 through September 17.

The revision of the Conference Policies and Procedures, which was prepared jointly by this Committee and the Procedures and Policies Committee of the Society, was approved by Council at the October meeting.

Conference Attendance Records.

1942	St. Louis, Missouri (2-day)	516
1943	New York, New York (1-day)	126
1944	Chicago, Illinois	721
1945	No Convention	.....
1946	Quebec, Quebec	807
1947	New Orleans, Louisiana	605
1948	Boston, Massachusetts	906
1949	French Lick, Indiana	668
1950	Pasadena, California	556
1951	Washington, D. C.	765

Procedures and Policies

Duncan Jones, Chairman

At the December 1950 meeting of Council, the report prepared by the 1949-1950 Committee (R. W. Staud, Chairman) recommended the approval of a revised statement of Procedures and Policies for National Technical Conferences of the Society. The Committee also presented recommendations in connection with the Policy on Preparation of Illumination Recommendations for Performance of Luminaires, the nomination of Society Directors, and a Medallist insignia. All of these Committee recommendations were accepted by Council.

The report of the Committee relative to the re-designation and revised qualifications of the grade of Member Emeritus, was accepted by Council and referred to the Committee on Constitution and By-Laws for the preparation of the related changes in the Society's Constitution. Subsequent discussion of these proposed Constitutional revisions at the February Council meeting disclosed that the revisions did not carry out Council's intentions. The revisions failed to receive the favorable letter ballot of Council.

Professional Requisites

J. O. Kraehenbuehl, Chairman

The studies of the Committee resulted in recommendations to Council concerning membership grades, privileges of the various grades of membership, membership dues, and the general status of the Society in relation to related professional engineering groups.

Public Relations and Information

J. S. Schuchert, Chairman

An outline of the plans, efforts and accomplishments of the Committee for the year follows:

(1) The procedure adopted during the previous year (whereby large expenditures would not be made to achieve public relations and information objectives but that a program would be conducted within the framework of the present staff personnel and volunteer committee membership) was continued during the past year.

(2) The objectives and procedures covered in the "Outline Proposed Program, Public Relations and Information," prepared during 1949-1950 formed a base for the 1950-1951 activities. Some phases were activated during the previous year; others were initiated during the present 1950-1951 administration.

(3) A consistent effort was continued to have an active local Public Relations and Information Committee appointed in each Section and Chapter. The results have been quite satisfactory. Most local units are now very active in this respect.

(4) A new Guide for Sections and Chapters entitled, "So You're in Charge of Publicity. . ." was prepared and sent to all local chairmen.

(5) A presentation suitable for talks or dramatizations entitled "I.E.S. Dividends" was prepared and sent to Chapter and Section Chairmen. They were encouraged to devote a meeting, or at least part of a meeting, to the story of the Society at which time they could use either all or part of the presentation, "I.E.S. Dividends" as a program guide.

(6) A national news bulletin was inaugurated (two issues were distributed during the year). These bulletins were prepared in "Kiplinger" style and summarized Society activities for those who are not too close to its operations or might not be a regular detailed reader of ILLUMINATING ENGINEERING. These news bulletins have received a very favorable reaction from all parts of the country.

(7) Suggestions were prepared covering ads in ILLUMINATING ENGINEERING. Advertising style messages were proposed to help publicize the Society to its members through the medium of its own publication. The ads emphasized one specific program or phase of the work of the Society.

(8) Releases were prepared and a schedule developed covering an advance publicity program in connection with the visit of the National

President to each Regional Conference or city on his itinerary. Very satisfactory results were obtained from this effort.

(9) All Chapters and Sections were requested to send a copy of their publicity on outstanding events, with photographs when possible, to the Editor of ILLUMINATING ENGINEERING and to the Committee. The various Chapters and Sections were impressed with the fact that the National Society is greatly interested in their efforts. It stimulated them to greater achievement and they were proud to send in evidence of their accomplishments.

(10) A four-page leaflet entitled "I.E.S. Dividends" was prepared with the original purpose of serving as a report to Sustaining Members. This report, in brief and illustrated form, found many other uses and is still serving as a very helpful selling and publicity tool for the Society.

(11) An outline of a Training Program for Regional Vice-Presidents and an additional program which the Regional Vice-President would conduct for Section and Chapter Officers were prepared and put into operation at the June meeting of the Local Activities Committee.

(12) A publicity program at the E.E.I. Sales Conference in Chicago included:

(a) An inexpensive but attractive and informative display.
(b) Distribution of the four-page leaflet mentioned above, "I.E.S. Dividends."
(c) A great deal of publicity from the stage (which had never been realized before).
(d) In order to stimulate interest and attract people to our exhibit, a drawing was held. Five of the new edition of the *IES Lighting Handbook* were provided as prizes. The stubs for the drawing were deposited in a box located at the exhibit. The ticket or form used for a "chance" at the drawing was prepared in the form of a bank check indicating the idea of dividends paid to the electrical industry from the Illuminating Engineering Society.

(13) A sub-committee was appointed who were assigned the task of reviewing the Membership Manual and the Sustaining Membership Brochure to bring them up to date and make them better sales promotion pieces. An annual review of this material should be made so that it is always kept fresh and appealing.

(14) Many other miscellaneous ideas were screened; some adopted and some were dropped. The Committee recommends that all sales promotional material which may have public relations or information value should be reviewed and, if advisable, revised each year by a sub-committee of the Public Relations and Information Committee.

(15) Suggestions have been made covering the increasing of publicity (particularly with respect to the accomplishments of the Society) in trade publications and consumer magazines.

(16) All of the above sums up to the fact that the Committee considers that the tremendous accomplishments of the Society are only partially understood by the membership and are practically unknown to the public at large. Thus, patient, relentless, aggressive effort must be continued as a permanent part of the Society's Public Relations and Information work. Creative thinking, ingenuity, enthusiasm and actual production of useful ideas and tangible materials, all within the framework of the budget and organization of the Society, constitute the challenging task of future Committees of Public Relations and Information.

Research Fund

L. E. Tayler, Chairman

The committee continued its development of approaches to the various parts of the lighting industry, and some of these have resulted in substantial contributions to the I.E.S. Research Fund.

Residence Lighting Forums

Jan Reynolds, Chairman

In addition to the three active Residence Lighting Forums associated with the Georgia, Michigan and New York Sections, a new one was organized in Chicago this year with a present membership of 50, including representatives of lamp and fixture manufacturers, architects, home service advisors, utility personnel and others directly or indirectly associated with the lighting industry. Although this newest Forum has only presented two programs to date, plans for a full schedule this coming year are already being formulated.

The Forums in Atlanta, Detroit and New York held a total of 19 meetings during 1950 and 1951 on varied phases of lighting and lighting design. These included new and unusual installations, color, lighting for sewing, photography in the home, architecture, several inspection trips, as well as a discussion of Contemporary Lighting in Traditional and Modern Interiors.

The Residence Lighting Forum of the New York Section, in addition to its eight regular meetings, sponsored again a series of eight lectures during February and March on Residential Lighting, in cooperation with New York University; also, a Design Competition was held to encourage students to design and apply proper lighting for a specific "average" home. This competition was completed, and on June 5th a tea was given honoring the five winners.

A morning session at the National Technical Conference in Washington included four non-technical papers on Residential Lighting.

Sustaining Membership

C. C. Shotwell, Chairman

This year's committee directed its efforts towards making a comparative analysis of two major problems:

(1) To study the contributions of present Sustaining Members and —

(a) arrive at an equitable plan for each category of solicitation of support, and
(b) to tabulate categorically the various segments of the industry and solicit additional contributions where the member was considerably out of line with the formula.

(2) To prepare for local Sustaining Chairmen, Prospect Lists by business classifications of the non-member firms in their territory requesting them to specifically approach these prospects for possible Sustaining support.

The first phase of this work, "Operation Utility," is well under way and when completed the other segments of the industry will be likewise analyzed, tabulated, and distributed for follow-up. This is a long-range program which, if supported at local level with industry and dispatch, should accumulate some real results in the course of the next few years.

The general operation of the Committee was pretty much the same as last year. A National Committee comprising one member from each Region and a local chairman in each Section and Chapter with committee membership size a matter of local determination.

There was, of course, the distribution to the present Sustaining Members of material prepared that would be of interest to them, particularly two News Letters and the very fine

Number of Sustaining Members and Dues for Past Seven Years.

	Number of Members	Dues Income
1945	237	$20,031.00
1946	265	21,881.00
1947	314	28,705.83
1948	326	30,209.37
1949	315	40,335.00
1950	316	40,235.00
1951	316	40,793.00

bulletin "1950 I.E.S. Dividends," both as prepared under the auspices of the Public Relations and Information Committee. Also considerable correspondence with the individual Sections and Chapters concerning the prospects and the suggestion of prospects.

Other activities in conjunction with the work of the Sustaining Membership Committee were as follows:

Mailing of letters by the Executive Secretary each month together with dues invoices to Sustaining Members being billed.

Follow-up each month to Sustaining Members and to Sustaining Membership Committee representatives concerning delinquent Sustaining Membership dues payments.

Correspondence concerning resignations which have been submitted or delinquent members to be dropped under the Constitutional provisions.

Mailings from the Publications Office to all the Sustaining Members announcing new publications.

Solicitation of the Sustaining Members for suggestions for the Section and Chapter Speakers List.

Task Committees

Joint I.E.S.-A.P.H.A.

E. M. Strong, Chairman

This committee was established to discuss with A.P.H.A. objectives of mutual interest in illumination, to review the relationship of light and vision, to study a rational basis for the quality and quantity of illumination and develop a list of researches desirable for further knowledge and cooperative effort.

The principal assignments to the committee have now been accomplished and the members of the committee are continuing their special efforts through the existing Society committees appropriate to their interest.

Advance Planning

R. W. Staud, Chairman

A report containing three recommendations of this committee was presented to the Council at its December meeting. The Council took action as follows:

Minimum reserve as specified in Article VII, Section 2(b), of the Constitution was amended by Council's letter ballot to more accurately specify the nature of the reserve.

Membership dues figures as specified in Article IV, Section 2, were amended by Council letter ballot and referred to the membership for vote with the annual election ballot.

The establishment of a new grade of membership—Junior Member was not approved.

Before his untimely death on March 28, 1951, the Chairman of the Committee R. W. Staud had directed the attention of the committee to other matters pertinent to the Society's long range planning.

Conference with National Council for Schoolhouse Construction

R. C. Putnam, Chairman

During the year the committee continued to maintain contact with members of the Council.

Fiscal Year

Berlon C. Cooper, Chairman

The committee continued its investigation of the problems involved in a possible change in the fiscal year, and reached no final decision in the current fiscal period.

Technical Committees

Aviation Lighting

Lewis B. Moore, Chairman

Several meetings of the Executive Committee were held during the year. Sub-committee chairmen reported on the activities of their groups and progress made toward the completion of sub-committee assignments.

The regular spring meeting was not held since all Committee efforts were again directed toward preparation for the Aviation Lighting Session at the National Technical Conference. In addition to the Conference program a Committee meeting is scheduled at which additional technical papers will be presented covering various phases of aviation lighting.

The status of the work of the various sub-committees, which are a part of the Main Committee, is as follows:

Sub-Committee on Aviation Lamps

V. J. Roper, Chairman

The list of "Lamps for Aircraft, Aerodrome and Airway Lighting, I.E.S.-S.A.E. Recommended Practice" has been revised to reflect civilian and military standardization and to include new lamps of recent design. This list with revisions, if approved, will be included in the revised *IES Lighting Handbook*. The sub-committee will remain active to further revise the list as new lamps are standardized for aviation usage.

Sub-Committee on the Compendium on Signal Lighting

F. C. Breckenridge, Chairman

Some progress has been made on the Compendium during the year and authors and reviewers are continuing their work on various chapters. During the past several months, however, it has been difficult for sub-committee personnel to devote much time to the work. Even though the material was divided into chapters to permit partial release and publication, time has not been available to fully complete any one section.

Sub-Committee on Airport Lighting

L. C. Vipond, Chairman

A complete revision was made to the section "Field Lighting for Airports" as included in the *IES Lighting Handbook*. Information relative to hangar lighting and terminal building apron lighting was also submitted for publication. An investigation is being made to determine the required beam pattern for high intensity runway marker lights and an analysis will be made of the results of flight tests conducted by the Civil Aeronautics Administration. Since standards for the lighting of small airports have not yet been accorded acceptance by all aviation interests no attempt has been made to cover this lighting application by a separate treatment. The sub-committee remains active and will continue its work.

Sub-Committee on Approach and Runway Lighting

No chairman

A special task committee was appointed to review the achievements and limiting conditions of the sub-committee's work with the purpose of recommending what future assignments, if any, would be made.

Sub-Committee on Aircraft Lighting

R. A. Rugge, Chairman

Progress has been made on the guide report for aircraft lighting but no definite date has yet been established for the completion of the work. The original draft of some 50 pages has been expanded and certain sections are about complete. The information is quite comprehensive but it is hoped that a good portion of the work can be completed within the next several months. A complete outline on aircraft lighting, submitted for *IES Lighting Handbook* publication, should be helpful to engineering personnel.

Sub-Committee on Taxiway Lighting

M. A. Warskow, Chairman

This sub-committee has continued work on taxiway lighting and the development of suitable route markers. The group proposes to keep in close touch with the experimental work being conducted by the C.A.A. at Indianapolis and will assist in the promulgation of satisfactory standards. A statement for interested glass producers is also being prepared to cover the consideration of an asymmetrical distribution lens for taxiway lights.

Sub-Committee on Definitions and Terms

J. F. Angier, Chairman

The recommendations of this sub-committee have hinged upon those of the International Civil Aviation Organization. Essential approval of ICAO definitions and terms has now been given by the Air Navigation Committee and formal approval by the main governing body is expected shortly. The sub-committee will then prepare a consolidated list of terms and definitions pertaining to lamps and lighting and such list will be circulated for consideration and action.

Sub-Committee on Lighting Study Projects

F. C. Ashe, Chairman

The sub-committee canvassed the membership of the Main Committee and obtained a list of subjects meriting special study. Some difficulty has been experienced in getting potential authors interested in undertaking the work suggested. An effort is being made to interest educational institutions in adopting some of the study projects for graduate research or theses. The task committee studying C.A.A. safety reports presented an interim summary but has been asked to more completely analyze air accident information to determine where such accidents can be attributed to faulty or misleading visual signals.

Sub-Committee on Papers

R. E. Madigan, Chairman

The paper presented at the October 1949 meeting "Recent Developments in Visual Low-Approach and Landing Aids for Aircraft" by Dr. Maurice A. Garbell has been abstracted and published in ILLUMINATING ENGINEERING (Vol. XLVI, No. 7, July 1951). Another excellent paper, "Lighting the Boeing Stratocruiser" by Mr. R. J. Helberg, was also published in that issue. Papers covering various major divisions of aviation lighting were presented at the 1951 National Technical Conference. Additional papers were presented to a Committee conference held in Washington concurrently with the Society meeting.

Color and Illumination

Ralph Evans, Chairman

During the year the committee made some progress principally by correspondence and informal discussion, toward a general evaluation of the effect of color in relation to the art and science of illumination.

Daylighting

R. L. Biesele, Jr., Chairman

Activities of the Committee for the past year were confined largely to the preparation of a revised Daylighting Section for the *IES Lighting Handbook*. This section was completed and forwarded to the Handbook Revision Committee early this year. Other activities of the committee have included preliminary studies of a uniform method for conducting a daylighting survey and for presentation of the data on such a survey. This is being assigned to a sub-committee for study in preparation of a proposed standard method.

A second activity under consideration, which would materialize in the program for 1951-52, is the development of a symposium on daylighting as a technical session for the 1952 National Technical Conference. It is contemplated that papers could be presented at that time covering research in this area conducted at the University of Michigan, Texas A. & M. College, and Southern Methodist University, by personnel and consultants of the Division of School House Planning of the California State Department of Education and at the laboratories of the Pittsburgh Corning Corporation. This subject has developed several controversial aspects, and it is believed that such a technical session would consequently be a lively one of considerable interest.

A third activity, on which no active steps have as yet been taken, but which should possibly be commenced during the coming year or the following year, would be commencement of activity toward revision of the Recommended Practice of Daylighting.

Farm Building and Work Area Lighting

P. H. Hildebrand, Chairman

The Committee met at Pittsburgh early in March to discuss and plan for the Farm Lighting Section of the revised *IES Lighting Handbook*. This was accomplished and the revised section, together with comments received by correspondence, was submitted for inclusion in the new revision.

A second meeting was held in Philadelphia in May. At this time the matter of publishing "Farm Lighting Data Sheets" was discussed. The Committee agreed that this would be a desirable project, and the chairman was authorized to discuss it with Council. Each member of the Committee was asked to secure photos and pertinent data on Farm Lighting installations, concentrating first on those lighting applications common to all farms.

Handbook Revision

B. J. Jensen, Chairman

Continuing in 1950-51, the Committee held five meetings to plan the project, decide policy questions that arose, and check progress. Manuscripts and illustrations for the Second Edition of the *IES Lighting Handbook* were prepared by the Technical Director's Office, working with the Handbook Revision Committee, from copy received from the technical committees of the Society and individual authors. These

were forwarded to the Publications Office beginning October 30, 1950 and periodically thereafter, with the last copy submitted June 7, 1951. Checking of galley and page proofs continued thereafter to publication. The Second Edition represents 75% revision of the First Edition. An estimate of the total Handbook pages, indicated that the Second Edition would contain approximately 815 pages exclusive of advertising.

Illumination Performance Recommendations

Ray P. Teele, Chairman

The committee held no meetings pending completion of laboratory measurements which were being made on a number of types of luminaires. Basic data on the relationship between discomfort and brightness distribution in the field of view were correlated with measurements on luminaires. A simplified method of using the basic data is being worked out. This year's work should enable the committee to complete its classification system for luminaires based on the photometric characteristics of flux and brightness distribution early in the next Society year. It is the committee's desire to have basic laboratory data behind the classification system and not to have it be empirical in nature.

Industrial Lighting

W. C. Brown, Chairman

The Committee has completed the revision of the Standard Practice of Industrial Lighting. This revision incorporates a considerable amount of information concerning the importance of the quality aspects of industrial lighting. The recommendations for specific footcandle levels have been coordinated with the report of the various study projects and the previous Standard Practice.

The proposed standard practice has been accepted by the Society's Council for submission to the American Standards Association as a proposed Standard Practice.

Light Control and Equipment Design

R. D. Bradley, Chairman

The Committee has begun the preparation of a tabulated guide which will be known as "Table of Materials and Finishes for Light Control" in which all of the commonly used metals, plastics, glasses and applied coatings will be tabulated and all of their pertinent engineering characteristics given. This table is now awaiting some additional information from various committee members, having definite assignments and will be re-compiled. After this table is prepared as a guide, supplemental information on each of the materials and subjects will be compiled with proper references and bibliography.

Light Sources

E. F. Lowry, Chairman

The various members of the committee have been very cooperative in revising and in bringing up-to-date the numerous tables and charts covering all types of light sources for use in the new edition of the *IES Lighting Handbook*.

Most of this work was handled by correspondence, but one committee meeting was held on December 13, 1950 in New York at which these matters were discussed. At this meeting the various members were asked to submit their opinions on what problems most urgently needed early solution. As might be expected, the replies received were mostly related to the characteristics of fluorescent lamps and their associated equipment. A summary of all such problems as submitted by the various members was prepared and circulated. Most of them were of such a nature that their investigation could only be undertaken adequately by the various lamp laboratories. Some of these problems were under investigation and the results of these studies were the basis for some of the papers given at the National Technical Conference in Washington.

Lighting and Air Conditioning

E. H. Salter, Chairman

Because of the difficulties in getting the committee together for meetings, the several items in the committee's assignment were in turn assigned to the individual members for investigation and report. Good progress has been made on certain of the items and plans are under way for attack on certain others, as follows:

(1) Action is under way toward obtaining the heat characteristics of commonly used lamps (spot, flood, fluorescent, etc.).

(2) A search is being made of the literature for information on the light and heat transmission characteristics of various glasses and other materials finding use in windows.

(3) Experimental work is in progress to determine the space distribution of radiant energy from lighting fixtures.

(4) No move has yet been made toward determining the effects of panel-heating installations on heat dissipation from fixtures.

(5) A bibliography has been prepared of publications on room comfort conditions as affected by radiant energy.

(6) No move has been made toward determining the effect of air-conditioning systems on light sources.

(7) A bibliography has been prepared of source material on lighting and air-conditioning.

(8) A list of study projects suitable for college graduate and undergraduate students is in preparation.

Lighting and Architecture

W. M. Potter, Chairman

In accordance with the committee's assignment an outline of a plan and procedure for lighting design competitions in architectural schools, was developed and submitted to Council for approval.

The suggested plan included statements on:

Purpose of competitions
Organizing for competitions
Problem
Rules of competitions
Lectures on lighting
Jury
Public presentation of prizes
Certificate of Award
As well as references to local competitions during 1950-51 run by Twin City Section and Cleveland Section.

The committee included among its recommendations that the promotion of such competitions be made a function of the Committee on Local Activities.

Lighting Design Practice

Neal Jacobus, Chairman

Individual assignments were made so that one or two members were investigating each of the following topics:

(1) To study manufacturers' short form presentation of lumen method

and make recommendations as to uniform manner of presentation.

(2) Study results of three research studies on verification of interflection method.

(3) Study results of experimental verification and extension of lumen method.

(4) Develop list of study projects suitable for college graduate and undergraduate students.

(5) Nomenclature relative to calculations.

(6) Calculating quality.

Correspondence has indicated that all members are especially interested in the accuracy of presently published coefficients of utilization as determined for use with the lumen method. Field experience requires a modification of these coefficients especially in light finished rooms.

None of the assignments have been completed but considerable background work has been done. It should be noted that these are all essentially new assignments in that last year the principal effort of the committee was directed toward the *IES Lighting Handbook* revision.

Lighting Education

C. E. Weitz, Chairman

Lighting Reference List.—A list of 97 textbooks and 17 trade papers and professional journals was compiled. The texts were classified into five arbitrary groups: (1) Lamps and Lighting; (2) Architecture and Lighting; (3) Physics of Light—Optics; (4) Color; (5) Light, Eyesight and Health —Related Psycho-Physiological References.

Survey of Illumination Courses in American and Canadian Engineering Schools.—A questionnaire survey form was developed and mailed to about 150 American and 38 Canadian colleges in June. Sufficient reports are not yet in to compile a significant summary to date. It is suggested that the task group on this project, W. E. Miller, University of Illinois, Chairman, summarize the results for possible publication in ILLUMINATING ENGINEERING.

Develop an Advanced Illuminating Engineering Course.—This was suggested as an Education Committee project three years ago, as a logical next step beyond the "fundamental" course outline now available from the Society. A review of so-called advanced courses reported by various Sections and Chapters show widely diverse subjects covered, depending on local needs at the time. Equally diverse were responses from individual committee members, depending on their viewpoint. It appears that there might well be many advanced course outlines prepared for specific interests or objectives, and it is therefore suggested that an advanced course project as such, be abandoned.

More Active I.E.S. Cooperation with the National Science Teachers Association.—This proposal was referred to our committee for investigation, specifically as related to revising and reprinting the Society's publication, "Experiments with Light" (about 1500 copies distributed during the past 5 years). This booklet, prepared by the 1937-38 committee, is designed around certain elementary but fundamental experiments, but obviously outdated because no mention is made of fluorescent or other sources except the filament lamp. A revision is in order, if such a publication is to serve any real future purpose. Little information is available on the principal end-use of this publication, though it has been listed by various writers of texts as source material; it is doubtful that it has been used as a supplementary school text. Some doubtful opinion has been expressed that it would ever have a large demand as a text for either elementary or high school science classes. It is suggested that revision be delayed until this or a new publication can be approached in purpose and content to meet rather specific objectives as a part of a program of cooperation with schools.

I.E.S.-U.S. Public Health Service—Sub-Committee on Preparation of a Lighting Survey Manual.—This project of three years standing has progressed through various stages of planning and revision. The latest revision consists of more than 100 pages of typewritten manuscript as submitted by the sub-committee Chairman J. F. Parsons.

Lighting of Central Station Properties

A. A. Brainerd, Chairman

Throughout the year the committee held three meetings, one one-day meeting was held in New York, two two-day meetings were held, one in Detroit, and one in Sunbury, Pa., respectively. The reports nearing completion are those on Recommended Lighting Practice for Outdoor areas, High Bay areas, Miscellaneous areas.

Lighting for Civilian Defense

L. J. Schrenk,
J. W. Bateman, Co-Chairmen

Toward the close of the fiscal year Council approved by letter ballot the establishment of this new technical committee—"To appraise and report on special lighting problems connected with emergency military operations that directly involve civilian defense and protection, such as equipment for bomb shelters, special street and vehicular lighting, mobile self-contained lighting facilities for use in bombed areas, and emergency lighting devices and visual aids to movement in the event of power failures."

Lighting Maintenance

D. C. Freeman, Chairman

The Committee held one meeting in February and discussed at length plans for developing a method of conducting maintenance studies. Discussions resulted in the outlining of a guide to provide a uniform method of measuring and reporting depreciation of lighting installations so that more accurate maintenance factors and maintenance intervals may be determined.

Lighting Study Projects in Industry

E. W. Fowler, Chairman

Lighting in Foundries, Frank E. Mueller, Chairman.

The extensive survey study and report drafting by the committee has resulted in a final report submitted to the general committee entitled "Lighting for Foundries."

Lighting in Laundries, O. H. Hill, Jr., Chairman.

Work has continued with testing the objective of developing the study report in 1952.

Lighting for the Leather Industry.

Since the suspension of work by the Newark, N. J., committee, due to the closing of the plant, negotiations have been carried on by several local groups and recently a possible opportunity for continuing the work has opened in the Wisconsin area.

Lighting in Steel Mills, A. Paulus, Chairman.

In March this Committee re-submitted the report "Lighting for Steel Mills, Part I: Open Hearth," originally presented to Council in June 1949, and subsequently this report received Council's favorable letter ballot.

Lighting in the Textile Industry, W. L. Kelley, Jr., Chairman.

During the year this committee submitted a supplement to the report, "Lighting for Woolen and Worsted Textile Mills." They actively studied other processes in the textile industries considering the enlargement of the committee's scope of work. The committee also conferred with Lowell Textile Institute at the University of Rhode Island and the Research Executive Committee of the Research Fund on the development of a study of the lighting for textile fiber processing.

Supplementary Lighting, W. H. Kahler, Chairman.

This committee has been bringing to completion its report on the Recommended Practice of Supplementary Lighting in which is developed the basic elements of the variety of seeing tasks found in practice. The committee also supplied a proposed section on supplementary lighting for the new American Standard Practice of Industrial Lighting.

Before his untimely death on May 1, 1951 Mr. Fowler had directed the work of many of the project committees toward the accomplishment of their objectives, including Lighting in the Canning Industry, Cleaning and Dyeing Industry, Fluid Milk Industry, Foundries, Laundries, Rubber Industry, Sheet Metal Stamping, Folding and Shearing, and Woodworking Industry.

Lighting Study Projects in Public Buildings and Private Institutions

R. S. Rogge, Chairman

One of the sub-committees, Lighting in Hotels, was temporarily discontinued this year but a new sub-committee, Lighting in Kitchens, Lunchrooms, Cafeterias and Dining Areas, was activated.

A meeting of the committee and subcommittee chairmen was held in Detroit, November 30, 1950. At this meeting the requisites for carrying out and preparing reports of Lighting Study Projects were discussed in detail. In addition specific objectives were set up for the various sub-committees, eliminating investigations which would duplicate activities of other committees.

The efforts of this committee are entirely reflected by the activity of the sub-committees, as follows:

Lighting in Auditoriums and Churches. — Submitted suggested revisions for new edition of *IES Lighting Handbook.*

Lighting in Hospitals. — Submitted revised section on "Hospital Lighting" for new edition of *IES Lighting Handbook.* Although there are some 8 distinct investigations to be undertaken, current efforts are being directed towards Patient Room Lighting and Laboratory Lighting.

Lighting in Kitchens, Lunchrooms, Cafeterias and Dining Areas. — This committee was formed to work in cooperation with an Advisory Committee of the National Restaurant Association to determine and set down lighting requirements for the various areas encountered in commercial and institutional kitchens, food serving and eating areas. It is the aim of this committee to accumulate data which will allow it to determine practical minimum lighting requirements. The first step was to select a specific area, study the seeing tasks and translate this into adequate lighting requirements.

It was decided to investigate the seeing requirements in the kitchen first. In order to become familiar with the terminology and nomenclature of the commercial kitchen, several people who were considered qualified in this field were asked to familiarize the committee with an explanation of terms and equipment. An accumulation of printed matter on this subject was made available to each member of the committee for further study and reference.

A study of the Department of Public Health regulations of three of the larger cities was conducted to see if there were any existing lighting requirements in these cities at the present time. The three studied were from Detroit, New York and Chicago. There seemed to be no definite lighting requirement mandatory in these cities.

To become familiar with some of the different types of kitchens and the type of work carried on in them the committee visited several of various types, large commercial kitchens, small commercial kitchens and deluxe kitchens.

So that the seeing tasks in each could be studied, the kitchen was divided into seven areas as follows: (1) Storage, (2) Vegetable preparation, (3) Quantity cooking, (4) Quantity baking, (5) Short order, (6) Food serving, (7) Dish washing.

At this point the committee was divided into seven sub-committees each to make a study of one of the foregoing areas.

Seven commercial kitchens were made available for detailed study. These kitchens were visited and the predominance and extent of each of the seven kitchen activities was recorded and a summary of this report was issued to each member of the committee. The chairman of each subcommittee could then select which kitchens would best serve as laboratories for their particular investigation. The sub-committees then began their work in the various kitchens. Preliminary reports from these subcommittees have been reviewed by the committee as a whole. Some of the physical and photometric characteristics of these kitchens are on record. The committee has arrived at the difficult point for all application committees—setting up standards of levels on which to base their engineering recommendations. When this has been settled satisfactorily, the committee will complete and submit the first part of its report — on the lighting of kitchens.

The next step, now under way, is to make a detailed analysis of the seeing tasks encountered from the time the trucks unload their materials on the loading deck until the waiter picks up the prepared food ready to serve.

Lighting in Theaters.—Submitted revisions for that section of the new edition of the *IES Lighting Handbook* relating to theaters. S. K. Guth's paper "Surround Brightness: Key Factor in Viewing Projected Pictures" is being studied and reviewed towards the possibility of including it in the committee's report.

A tentative outline of future activity includes the following: (1) Determine a range of brightness or brightness gradient in the field of view for comfortable viewing of motion pictures in theater auditoriums of different proportions. (2) Establish range of brightness values for auditoriums between pictures and during stage presentations. (3) Suggest design methods of obtaining such results. (4) Establish range of illumination values for various acting, scenery and prop areas of the stage with factors for color included. (5) Establish direction, distribution and diffusion characteristics of components of the lighting system for the stage. (6) Suggest lighting equipment layout and modifications for various types and sizes of stages.

Mine Lighting

G. F. Prideaux, Chairman

The committe held its first meeting in Birmingham, Alabama, the week of March 26. The committee first visited two modern coal mines; one operated by the Alabama Power Company and the other by the Tennessee Coal, Iron & Railroad Company. They next visited a modern iron ore mine also owned by the Tennessee Coal, Iron & Railroad Company. The last day of the meeting was devoted to reviewing the information obtained on these inspection trips from the standpoint of the visibility levels encountered, the overall lighting and other attendant problems involved in improving seeing.

Three Sub-Committees were formed to carry on activities in the three most important phases — Sub-Committee on Studies of Visibility Levels Encountered in Mines, Arthur Eastman, Chairman; Sub-Committee on Methods and Materials for Whitening Mine Interiors, E. J. Gleim, Chairman; Sub-Committee on Development of Permissible Mine Light Equipment, W. H. Kahler, Chairman.

Nomenclature

Harris Reinhardt, Chairman

During the year the revision of the first two sections (05 Photometric Quantities, 10 Radiation) of A.S.A. Z-7 Illuminating Engineering Nomenclature and Photometric Standards was completed and approved by Council.

Numerical values in the two sections were brought up-to-date, and certain terms in the two sections were changed to forms which the Optical Society of America felt were needed in the official A.S.A. definitions.

All of the changes were made in such a way that the ordinary working vocabulary of the illuminating engineer is not necessarily affected.

One of the major changes was the replacement of the term "brightness" by the more precise term "photometric brightness," with a new term "luminance" shown as an alternate.

Various Society committees are assisting in the revision of the other sections of Z-7 and in the preparation of certain new sections which are to be added. These are in various stages of progress.

Office Lighting

G. P. Wakefield, Chairman

Activities over the past year have been centered on a new Recommended Practice of Office Lighting.

In the report of last year the committee unanimously recommended the discontinuance of further action in having the 1947 practice approved by American Standards Association because of the divergencies between the American Standard Practice of School Lighting and the Recommended Practice of Office Lighting. In essence the new Recommended Practice will be based upon comfort and performance of the office worker. It will insure a comfortable seeing environment suitable for maximum performance of the tasks. Most research enabling such a version has been completed and will be incorporated in the new Recommended Practice.

Progress

Alston Rodgers, Chairman

The committee maintained contact with the art of lighting throughout the world and prepared a yearly review of the achievements in the Art of Lighting for publication in ILLUMINATING ENGINEERING. This review was given a dramatic presentation as one of the features of the 1951 Washington, D. C. National Technical Conference.

Protective Lighting

J. W. Lee, Chairman

The committee brought to completion two year's work on the revision on the American War Standard "Protective Lighting for Industrial Properties A-85, 1942," and submitted it for Council approval at the end of the fiscal year.

Public Conveyances—Interior Lighting

E. W. Beggs, Chairman

A two-day meeting of the committee was held on March 28 and 29. The first objective was to complete a study on the application of fluorescent lamps to railway cars, buses, etc. That was done and it has been written up in a preliminary report. The second objective was to revise the section of the *IES Lighting Handbook*. The final draft of the revision was drawn up and sent to the committee, prior to publication.

Research

H. L. Logan, Chairman

A sub-committee, S. K. Guth, Chairman, canvassed the Society's technical committees to secure suggestions for the development of a list of study projects suitable for undergraduate and graduate levels in universities. Another sub-committee, Prof. Miles A. Tinker, Chairman, undertook a survey of the whole field of lighting to determine and report on subjects requiring scientific verification through research. Assisted by C. L. Crouch, Technical Director, the committee continued its survey of research institutions carrying on studies in light, vision and visual environment.

Residence Lighting

Mary E. Webber, Chairman

The original agenda presented for the consideration of the Committee included the following projects for the year's work, and accomplishment in each is shown as follows:

Preparation of a List of Residence Study Projects for Undergraduates in Schools Offering Home Economics and Electrical Engineering. — A questionnaire was sent out to a representative list of institutions offering home economics and electrical engineering degrees two years ago. Compilation of the returns previously reported proved in majority a low order of interest and understanding even on the part of the department heads. In addition, such an insignificant amount of time was devoted to lighting instruction that it seemed clear students would be ill

equipped to undertake serious lighting studies. Even facilities for worthwhile technical research also seem almost completely lacking. For these reasons it was the committee's studied opinion that such a list would have no practical value at the present time.

The experience of the committee members in contacting home economics departments at the college level indicates the first need is for up-to-date source information to guide the instructor in what little home lighting training is included in curricula. The committee proposed the preparation of a resource list (materials, teaching aids, bibliography) on the subject of home lighting. It was learned, however, that there is no feasible method, in established Society policy, for the wide and useful distribution of such a list. If some means can be worked out to offer such a reference list, the committee believes it should be undertaken.

Development of a List of Study Projects on Residence Lighting for Society Volunteers.—A list of subjects for Study Projects has been completed. A list of this type was prepared a number of years ago. It resulted in the publication of technical papers covering each of the subjects. Howver, with one exception, these papers were undertaken by members of the Residence Lighting Committee. This may be a fair indication of the condition that relatively few members of the Society assume responsibility for this most common field of lighting application.

Review for Revision of "Lighting Performance Recommendations for Portable and Installed Luminaires."—There was no possibility of undertaking a revision of the body of this publication. The subject material in its Appendices A and B already has been revised as previously reported. This text was prepared over several years by a Sub-Committee of outstandingly qualified engineers who contributed unusual experience and countless hours to it. Only one member of that Sub-Committe is still serving on the Residence Lighting Committee. Until such time as the Society can interest equally devoted and qualified members to serve on the Residence Lighting Committee, no major revision of this work can be fairly undertaken. The Committee is well aware that clarification and simplification of the present work, its suggested methods of discomfort glare evaluation and required testing procedures are clearly needed.

Revision of "Recommended Practice of Home Lighting."—This work is well under way. It has in fact been the major work of the year. Two years ago, the then Chairman Mr. Commery appointed Miss Janet Reynolds to study the problem. Other projects during that time took precedence in Committee attention to this project. This year, however, a sub-committee was appointed to work with Miss Reynolds. It was the studied decision of the major committee that this work required complete rewriting rather than mere revision due both to the developments since its last minor revision in 1947 and to the changing Society policies in regard to recommended practices. A completely new outline was approved early in the year and first drafts of much of the proposed material have been discussed. Much work remains to be done but it is hoped that with concentration on this project another year it may be completed.

Technical Session at National Technical Conference.—As has been the case for many years now, the committee has assumed the responsibility for stimulating sufficient papers to assure a technical session on residence lighting at the Annual Conference. This year, four papers were prepared, two by Committee Members Miss Priscilla Presbrey (a joint paper with Miss Buchholtz) and Miss Janet Reynolds and two others by Mr. E. W. Commery (jointly with T. Knowles) and by Miss Kaye A. Leighton.

School Lighting

R. C. Putnam, Chairman

The main task of the committee for the first part of the fiscal year was the completion of the material on School Light for the Second Edition of the *IES Lighting Handbook*. In addition the committee continued its review of seeing and lighting problems in educational institutions in the selected fields for study projects, including Brightness Conditions in Educational Environments, Chalkboards, Student Vision and Scholarship and Visual Problems.

Sports and Recreational Area Lighting

R. J. Swackhamer, Chairman

A current Recommended Practice for Lighting Sports and Recreational Areas has been prepared, approved by Council at its October 1950 meeting and prepared for publication (Part I appeared in ILLUMINATING ENGINEERING, Vol. XLVI, No. 11, November 1951). A representative portion of this current recommended practice was used in the *IES Lighting Handbook*.

There are several sports and recreations that have not been studied, and, therefore, the committee's activity can well be directed to investigating these applications. It is conceivable out of further committee investigation will come a request for study projects. The Recommended Practice needs supporting or substantiating data that would involve the principles of vision of objects in motion simulating those found in sports from the player and spectator point of view. Relative horizontal and vertical components of illumination together with background brightness and optimum perception of objects is also needed.

Standards of Quality and Quantity for Interior Illumination

Willard Allphin, Chairman

The committee is working on a revision of report #1 Brightness and Brightness Ratios with particular reference to the bases for specifying brightness ratios. No report on this will be ready this year. The committee has also met a request for advice from the Research Committee in regard to a proposed project.

Store Lighting

D. P. Caverly, Chairman

This year the committee's major project was the preparation of copy and illustrations for the Store Lighting portion of Section 10 in the revised edition of the *IES Lighting Handbook*. This work was carried over over from the previous year, and after four drafts and extremely careful editing by the committee members the work was completed early in 1951.

Many dozens of photographs and illustrations were screened by the committee and in April 1951, the final selection was approved. All of this material was submitted to the Handbook Revision Committee.

In addition to the above, the committee made preliminary reviews and studies of the Recommended Practice for Store Lighting.

Street and Highway Lighting

R. M. Zabel, Chairman

The Sub-Committee on Pavement Surfaces, F. D. Wyatt, Chairman, has continued its I.E.S. Research Fund sponsored work on the reflectance characteristics of pavement surfaces. Prof. J. O. Kraehenbuehl of the University of Illinois, who is carrying on this research project, has completed readings on a number of pavement samples.

The Research Sub-Committee, K. M. Reid, Chairman, has analyzed some of the pavement reflectance information obtained by Prof. Kraehenbuehl and demonstrated how it can be applied to practical seeing conditions. This committee's cooperative study with Prof. R. C. Putnam of Case Institute of Technology resulted in a paper by Prof. Putnam entitled "Preliminary Analysis of Pavement Reflectance Data" which was presented at the Washington Conference.

The Sub-Committee on American Standard Practice, C. H. Rex, Chairman, has completed its work. The revised Standard Practice was presented to and approved by Council at the June meeting. It remains to be approved by the American Standards Association. The revision of the Standard Practice retained the basic illumination requirements of the existing Standard Practice. Alterations have been in the interest of greater accuracy, understandability and simplification.

The Sub-Committee on Program and Publicity, D. W. Rowten, Chairman, was instrumental in encouraging the presentation of eight papers dealing with street lighting at the Washington Technical Conference.

G. K. Glass, Chairman of the Sub-Committee on Public Lighting and Traffic Safety, represented the Society at the President's Highway Safety Conference.

A Sub-Committee on Tunnel and Underpass Lighting, R. M. Swetland, Chairman, has been appointed. It is the purpose of this committee to study current practice in this field as a preliminary to the formulation of a standard practice defining lighting requirements for these specific locations.

The Sub-Committee on Low Level Lighting, R. G. Slauer, Chairman, is to study the possibilities of low level lighting as a future approach to street lighting practice.

Technical Committee Forum

S. G. Hibben, Chairman

At the invitation of the Forum, a meeting of all technical committee chairmen was held early in the fiscal year for a discussion of basic standards upon which to build committee work, to consider lighting study techniques, and to discuss committee problems. The chairman assisted by C. L. Crouch, Technical Director, presented a Technical Committee Forum at the Washington National Technical Conference summarizing the achievements of the technical committees during the year.

Television

E. W. Commery, Chairman

Detailed procedure for investigating the lighting and viewing habits of the American Family has been developed from field studies in typical homes. Committee members will undertake the supervision of an extended number of surveys in a number of cities. Special limited studies of attainable picture high light brightnesses are nearing completion.

Testing Procedures for Illumination Characteristics

G. A. Horton, Chairman

The committee reports progress as follows on its principal assignments:

(1) List of Study Projects Suitable for College Undergraduate and Graduate Students. This project was completed in June 1951, the report being submitted to Mr. S. K. Guth, Chairman, Sub-Committee, Research Committee.

(2) Review — "I.E.S. Standard Method or Measuring and Reporting Illumination from Artificial Sources in Building Interiors," ILLUMINATING ENGINEERING, Vol. XXXVIII, p. 75 (February 1943). Arrangements were made by Mr. J. F. Parsons with Prof. H. M. Sharp of the University of Buffalo that a study be made by students as to the reliability of the I.E.S. method. Prof. Sharp's report has been received and states in part:

"It is evident that any lighting system providing a high degree of diffusion such as indirect, semi-indirect, or direct-indirect can be measured to a high degree of accuracy by means of the I.E.S. method. Error in all rooms investigated is less than three per cent. "The method is therefore sound and the results well within the tolerances accepted in practice."

(3) Revision along the lines of the I.E.S. Guides to Testing Procedures—"Testing Specifications for Lighting Equipment." The combined revision of Parts I and IV of the Testing Specifications is well along, being in the stage of the fourth preliminary draft. With regard to part III, manufacturers of this class of lighting equipment have been contacted and replies indicate that this section should be simplified to conform to present practice.

(4) Review for revision — "Report of Committee on Photoelectric Portable Photometers," Trans. I.E.S., Vol. XXXII, p. 379 (April 1937). Only slight progress has been made in this project.

The following projects were added to the agenda by the committee:

(1) Preparation of an "I.E.S. General Guide on Photometry." This is being done to eliminate the necessity of including photometric principles in each Testing Guide. A preliminary draft has been prepared and will be considered by the committee as soon as the figures which accompany the text are finished.

(2) Preparation of an "I.E.S. Guide for the Photometric Testing of Fluorescent Street Lighting Luminaires." Special treatment of this type of luminaire was indicated because of the temperature problems involved. This is at present in the study stage.

(3) Preparation of an "I.E.S. Guide for the Photometry of Searchlights." With the renewed interest in searchlights due to the defense effort, the committee is investigating the possibilities of preparing a Guide covering the photometry, to include filament, discharge, and carbon arc sources.

(4) Preparation of an "I.E.S. Guide for computing Lumen Distribution and Isolux Diagram on a Horizontal Plane from the Standard Floodlight Photometric Test Report." A preliminary draft is in preparation.

Provisional use by the American Standards Association of the following Guides was authorized by the committee:

(1) I.E.S. Guide for Electrical Measurements of Fluorescent Lamps—1948.

(2) I.E.S. Guide for Life Perform-

ance Testing of Fluorescent Lamps—1948.

(3) I.E.S. Guide for Photometric Testing of Fluorescent Lamps—1948.

The "I.E.S. Guide for Photometric Testing of Floodlights of 10 to 160 Degrees Total Beam Spread," which was prepared in the previous term was published in the March 1951 issue of ILLUMINATING ENGINEERING.

The "I.E.S. Guide for Outdoor Illumination Tests" was developed in 1948 and 1949 by the Committee to fill a need experienced by engineers doing field testing. It was presented to Council in June 1949, approved in March 1950, and then revised slightly in the present term to meet objections raised by the Sports and Recreational Area Lighting Committee, Street and Highway Lighting Committee, and the NEMA Floodlighting Technical Committee.

A "round robin" test of fluorescent lamps to determine the agreement between laboratories as regards their testing methods was initiated in the previous term. The first laboratory where measurements are to be made has partially completed its work.

An Analysis of Fluorescent Luminaire Brightness

Additional Discussion and Rebuttal on paper by John J. Neidhart

(Published November ILLUMINATING ENGINEERING pp. 569-576)

JOHN A. LOSH*: The author has publicly advanced a noble concept—that the brightnesses of a luminaire be plotted on a polar graph. We would like to make a simple amendment to this: that the brightness unit be made candle per square inch instead of footlambert. We have found that because the numbers are smaller they are easier to handle mentally. That is, one can usually determine the ratio of 3.7 to 2.6 easier than he can the ratio of 1672 to 1175.

We also believe that the knowledge of the average luminaire brightness is essential, but the quotient of candlepower to area is *not* the average brightness unless we are at a sufficient distance from the luminaire. Inasmuch as this paper deals with fluorescent luminaires, that distance is something in excess of 20 feet. The average brightness of a luminaire must be measured at the same distance from the luminaire as is the maximum brightness in order to be significant. This may explain the author's maximum/average brightness ratios which are less than unity. Perhaps a device similar to that described by Potter and Russell could be used to determine the average brightness.

The author in his presentation of this paper said he hoped that by presenting such information as is contained in Table I he had shaken our faith in maximum brightness as a measure of luminaire performance. Rather he has pointed up what should have been well known: that the brightness is a function of among other things, the shape of the aperture. I hope that nobody expected the brightnesses as measured with different apertures would be the same. The author forgot to mention the second and equally important criterion of a brightness meter, that of the solid angle subtended by the aperture at the center of the lightcell. The "I.E.S. Guide to Photometric Testing" contains no hint as to what this solid angle should be, hence the brightness meters in use in this country do not generally have the same angle. Thus, even with a 1" square aperture, different brightness meters will indicate different brightnesses. This is a shortcoming, not of maximum brightness, but rather of the non-theoretical specification of parts of a brightness meter.

JOHN J. NEIDHART**: Mr. Losh's comments are much appreciated, and it is well that he has called attention to some points that were not covered in the original paper. His first suggestion the brightness be reported as candles per square inch has merit and is a long standing point of disagreement by various groups and individuals in our Society. I do not propose to carry the argument into these pages but will merely point out that (1) the footlambert is becoming increasingly popular and (2) ratios of luminaire to adaptation or room surface brightnesses are more simply and directly obtained if footlamberts are used in every instance.

Although Mr. Losh is quite correct in pointing out that the apparent candlepower at a normal viewing distance may be somewhat higher than the candlepower as measured at a test distance equal to 5 times the greatest source dimension, I do not believe that this should be considered as a sufficiently serious error to necessitate cumbersome and difficult correction. In their 1951 National Conference paper* Horn, Little and Salter show that the maximum error that we might expect in practical applications would be less than 10 per cent. The larger errors that they show for endwise viewing are found at high angles where in practical installations the luminaires would normally be far enough from the eye to minimize the error. They show no error for crosswise viewing.

It is true that the dependency of brightness upon aperture size *should* be well-known, but the fact remains that very few people seem to realize it. My point is that we have a testing guide that encourages the use of different apertures so that one can never be certain that maximum brightness data for different luminaires were measured on the same basis.

I am very glad that Mr. Losh has pointed out the importance of the solid angle that the photocells "see" through the aperture of a brightness meter. The original draft of my paper contained some reference to this, but I decided to omit it to comply with space limitations stipulated by the Papers Committee. One way in which this error may be minimized is by increasing the distance between the aperture and cell. For years the instruments used had only one foot between cell and aperture. We increased this distance to two feet over two years ago, and I understand that other laboratories have recently changed to the longer tube. There is, however, no specification requiring the use of such an instrument or any limitation other than the conscientiousness of the laboratory upon the aperture to luminaire distance. I hope that all such variables in maximum measurements can be tied down more explicitly if we are to continue reporting maximum brightness data in any form.

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*Smithcraft Lighting Div., A. L. Smith Iron Co., Chelsea, Mass.
**Author.

*Preprint #19 "Relation of Distance to Candlepower Distribution from Fluorescent Luminaires."

Questions and Answers on Light Sources

The I.E.S. Committee on Light Sources, under the chairmanship of E. H. Raddin, has prepared this listing of answers to frequently-asked questions. Similar questions of general interest on light sources will be published from time to time.

Q. Is there such a thing as Black Light?

A. No. Black Light is a popular name given to the long wavelengths of invisible ultraviolet radiations (360-380 millimicrons) which are used to excite phosphorescent and fluorescent paints used on theatrical costumes, displays, etc. The term was given to this ultraviolet range because whenever fluorescent materials were examined in the dark under the radiations, the observer's hands and face appeared black by contrast.

Q. What is an "exciter" lamp?

A. The term "exciter" lamp is sometimes used to describe the "sound reproducer" lamp. These lamps have a low voltage precision filament in the form of a short coil. A reduced image of this filament is projected by an optical system on to the sound track of a motion picture film. A photocell detects the variations in intensity of this image as the sound track passes between the image and photocell. The photocell current is then converted to sound by the associated amplifier-speaker equipment.

Q. What is the result of operating fluorescent lamps at (a) low ambient temperatures, (b) high ambient temperatures?

A. For the most efficient generation of 253.7 millimicrons, ultraviolet and, therefore, the highest light output, a fluorescent lamp should operate at a mercury pressure of 8-10 microns. This means that the condensed mercury temperature should be roughly 45°C (113°F). Very low or very high ambient temperatures will result in corresponding variations in the mercury pressure in the lamp. In either case, the light output of the lamp will suffer. A decided color shift in the light emitted will be quite noticeable. At low temperatures the color will shift toward the red. At high ambient temperatures this color shift is toward the green, due to increased brightness of the blue and green mercury lines at the same time that the light generated by the phosphor is decreased.

Another important effect is a noticeable increase in starting difficulty. This is so marked an effect that special lamps are made for use at ambient temperatures below 40°F. At high ambient temperatures (above 140°F) restarting of lamps becomes quite difficult.

See also J. C. Forbes and R. J. Diefenthaler "Effect of External Factors on Light Output of Fluorescent Sources," ILLUMINATING ENGINEERING, Vol. XLI, No. 10, p. 872 (December 1946).

Q. Why do projection and photoflood lamps have such a short life?

A. Photoflood and projection lamps have a relatively short life compared with household lamps. This is necessary to achieve the high light output and more advantageous color required for good photographic efficiency or screen brightness. At the high filament temperatures required to produce maximum light, filament evaporation is more rapid and life consequently shorter.

Q. How does a photoflash lamp operate?

A. Lamps of widest application consist of a plastic coated glass bulb containing two lead wires and a fine filament. The ends of the filament leads are coated with a primer material. Surrounding the lead wires is a mass of shredded aluminum foil in an atmosphere of oxygen. A battery supplies current which heats the filament white hot causing the primer to flash; the burning primer particles are scattered throughout the aluminum foil and ignite it as the foils burns readily in oxygen. The burning foil produces an intense light which increases rapidly to a maximum and then decreases to zero in about 1/30 of a second.

For use with cameras having focal-plane shutters shredded-foil lamps of special design are used. These maintain light output through a longer period.

In another type of photoflash lamp of lower total light output no aluminum is used. Instead the light is produced by very rapid combustion of a larger amount of the primer material. The flash duration is only about 1/100 of a second.

T E L E C A S T
LIGHTING NEWS OF CURRENT INTEREST

"Eyes for Defense" Is Keynote Of Occupational Vision Conference

An impressive assembly of more than 300 delegates attended the Conference on Occupational Vision, held November 1-2 in Atlantic City, N. J. under the auspices of the Extension Division of Rutgers University.

The Conference was sponsored, in cooperation with numerous companion National Societies, by the Illuminating Engineering Society with the backing of the New Jersey Optometric Association. The enthusiastic work done by Dr. John R. Wittekind of that Association and by Professor M. A. Chaffee of the Extension Division, with the backing of President L. W. Jones of Rutgers University, provided an unusually talented panel of speakers on industrial lighting, care and hygiene of the eyes, visual efficiency and the organization of visual programs and employee training. I.E.S. President S. G. Hibben was Moderator of the half-day session, a Forum on Lighting and Color, at which S. K. Guth, H. L. Logan and Faber Birren presented papers.

The two-day program consisted of four sessions which were:

Forum on Needs and Values—E. H. Westland, Chairman, Committee on Occupational Vision, American Optometric Association, Presiding.

What a Visual Program Means to Employer, Management, and the Community—L. Holland Whitney, M.D., Medical Director, New Jersey Bell Telephone Co.

Savings in Insurance Through Vision Programs—William H. Seymour, Vice-President, Loss Prevention Department, Liberty Mutual Insurance Co., Boston.

What a Well-Organized Visual Program Means in Labor Relations — Lowell F. Johnson, President, New York Industrial Relations Association.

Forum on Lighting and Color — S. G. Hibben, President, Illuminating Engineering Society, Presiding.

Some New Concepts on Lighting and the Job —S. K. Guth, Lighting Research, General Electric Co., Cleveland.

Lighting as a Means of Reducing Accidents in Industry—H. L. Logan, Research Department, Holophane Co., New York.

Functional Color for Better Human Efficiency and Safety, Faber Birren, Color Consultant, New York.

Forum on Eye Safety — Hon. Percy A. Miller, Jr., Commissioner, New Jersey Department of Labor and Industry, Presiding.

Occupational Vision Hazards—Commander R. R. Sullivan, Optometry Section, Medical Service Corps, Bureau of Medicine and Surgery, U. S. Navy.

Eye Injuries in Industry and Their Emergency Care—Hedwig S. Kuhn, M.D., Secretary, Joint Committee on Industrial Ophthalmology of A.M.A. and A.A.O.O.

Savings Through Accident Control — W. N. Cox, Jr., Professor of Safety Engineering, Georgia Institute of Technology.

Forum on Visual Efficiency — John R. Wittekind, O.D., Chairman, Committee on Occupational Vision, New Jersey Optometric Association, Presiding.

The Relation of Visual Efficiency to Motion and Work—Allan H. Mogensen, Director, Work Simplification Conference, Lake Placid, N. Y.

Installation and Operation of Vision Programs in Industry—Lt. Robert J. O'Shea, Occupational Vision Section, Medical Service Corps, U. S. Army; Maryland Society for the Prevention of Blindness.

How to Organize a Workable Vision Program —Prof. Henry B. Peters, School of Optometry, University of California.

The interest with which many of the delegates, representing a large percentage of country-wide industrial and business organizations, entered into discussions on almost all phases of the program was good evidence of the interest that industrial organizations, as well as safety, health and medical groups, are taking in the co-relation between usable eyesight and the conservation of efficient utilization of productive manpower, materials and time. An overall appraisal of this Conference included the sentiment in favor of more exact knowledge regarding characteristics of human vision; more exchange of knowledge on best lighting practices; better comprehension of the difference between "more light" and "good light." At this time the humanitarian aspects of conserving eyesight were joined with the vital economic importance of better vision as one of the greatest factors enabling industrial America to meet the war-time demands upon its health and productivity.

Maurice A. Chaffee

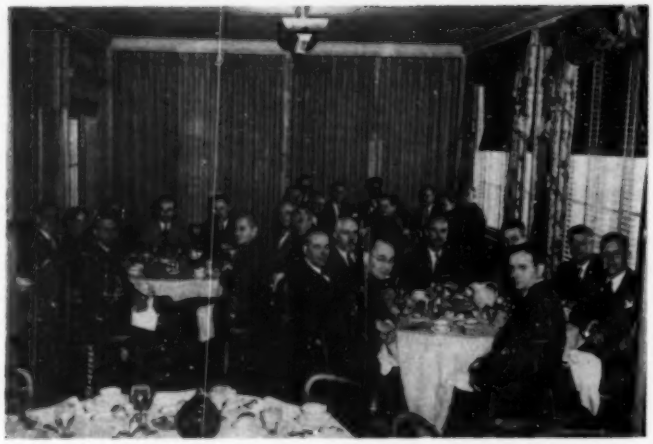
John R. Wittekind

European Lighting Trends Subject of Joint I.E.S. Meeting

Impressions of European lighting practices were the subject of a joint meeting of the New York Section, I.E.S. and the New York Residence Lighting Forum, November 20.

Miss Myrtle Fahsbender, Director of Home Lighting at Westinghouse Electric Corp., spoke on residential lighting in England, France, Belgium, and the Scandinavian countries, which she inspected on her trip through Europe last summer.

C. M. Cutler, of the General Electric Co., described commercial installations he witnessed abroad. The talks were both illustrated with slides of European lighting equipment and both residential and commercial interiors. Actual equipment was also on display.



At the front table at the meeting of the Technical Committee Forum, beginning at left (9 o'clock) and reading clockwise, are Ward Harrison, Edward Rambusch, E. W. Beggs, G. A. Horton, F. D. Wyatt, W. C. Brown, Willard Allphin, D. P. Caverly. At the left rear table: C. L. Crouch, Eve Freyer, E. M. Strong, D. C. Miller, Howard Haynes, E. W. Commery, S. G. Hibben, J. W. Lee, A. A. Brainerd. At the right rear table: J. M. Chorlton, J. W. Bigley, C. E. Weitz, C. M. Crysler, A. H. Clarke, E. H. Church, R. P. Teele, J. J. Neidhart, E. H. Raddin.

Technical Committee Forum Holds Meeting in Syracuse

The chairmen of the technical committees of the Society met recently, on the invitation of Prof. E. M. Strong, Chairman of the Technical Committee Forum, to confer in Syracuse, N. Y. The meeting particular committee, the work it intends afforded an opportunity for the chairmen to speak concerning the problems of each to accomplish in the coming year with considerable group discussion of the problems and excellent suggestions for ways in which the committees can cooperate in their work.

President S. G. Hibben spoke, emphasizing the importance of the work of these committees, stating that their reports are major achievements of the Society.

Ward Harrison, speaking as Chairman of the I.E.S. Research Fund Executive Committee, described the operation and objectives of the fund and its relationship to the technical committees, and suggested that they submit requests for research. He stated that "The Fund welcomes and solicits proposals leading to fundamental research in the fields of any of the technical committees."

Mr. Crouch, Technical Director, discussed the accomplishments of the technical committees from 1945 to the present time, using colorful bar graphs showing the number of meetings, work on the *I.E.S. Lighting Handbook* revision and committee reports.

A summary by Prof. Strong expressed the significance of the technical committee work to the Society.

After dinner on Monday evening the group was entertained by Mr. A. A. Brainerd showing colored slides of a six-week trip through Sweden, which he made last summer after attending the Stockholm meeting of the International Commission on Illumination. This was followed by an explanation of the Commission by Mr. Brainerd and of the 1951 session in particular by Willard Brown and S. G. Hibben.

A. H. Clarke, Chairman of the Sports and Recreational Area Lighting Committee, was host to the Forum gathering and made the arrangements for its meeting.

New England Town Installs Fluorescent Street Lighting

Lyndonville, the ski resort in Vermont, is the first town in New England to put into operation a fluorescent street lighting system, said to be the nation's second major installation.

Each of the eight-foot-long luminaires is equipped with four slimline lamps with total output of 22,000 lumens. Mounted on aluminum poles approximately 30 feet about the 60-foot-wide main street, the luminaires are staggered about 75 feet apart. The average calculated illumination is one footcandle.

Iowa Fall Conference Features School Lighting, Light Control

The annual Fall Conference of the Iowa Section, I.E.S., one of four full-day Conferences held each year by this Section, was held November 16, in Waterloo, Iowa. The meeting opened with a talk by Melvin R. Beckstrom, an architect of Moline, Ill., who spoke on the lighting design of the new George Washington Elementary School in Moline, which includes the adaptation of some old and some new ideas in school lighting.

E. K. Decker, engineer with Superior Electric Co., Bristol, Conn., followed with a discussion on "Lighting Control" including a demonstration on dramatic and useful lighting effects with the newest equipment in resistance, auto-transformer and electronic dimming for churches, theaters and even in homes.

The afternoon program included an inspection tour of the new lighting installations on the sales floor and offices of the Iowa Public Service Co. in Waterloo, Iowa, with Charles Gehan and Merle Jones as tour guides.

A sociability hour and banquet concluded the day, which was the first "official" appearance of the new Chairman, Chester P. Stone. The Program Committee was headed by Giles Crider and C. R. Wagoner is chairman of the Local Arrangements Committee.

Chicago Section Reviews 1950-1951 Progress

In a report to the members of the Chicago Section on activities during the 1950-51 year, C. B. Pederson, retiring Chairman, reviewed the accomplishments of the Section toward realizing the objectives outlined a year ago.

Re-activation of the Residence Lighting Forum was one of the major objectives and the Forum, now with 40 members, is working to assure orderly growth and development.

Increase in membership was rewarded by third prize in the national Society contest, with the prize money being turned over to the Scholarship Fund.

The Section's Papers Committee established new records by having four of the six papers submitted approved for publication in ILLUMINATING ENGINEERING.

The Study Club of Central Illinois has achieved a firm footing and now has more than 40 members.

These achievements plus increased membership attendance at meetings and the well-balanced social and entertainment program were considered by the members of the Section as real progress.

Basic Course in Lighting Presented in New England

A six-session course in the basic principles of lighting, light sources, practices and equipment was presented during October and November by the Lighting Bureau of the Electric Institute of Boston and the New England Section of I.E.S. The lectures were supplemented by demonstrations, training films and slides. Subjects of the six classes were:

Physics and Measurements of Light
Light Control and Equipment
Light Sources
Color and Paint
Quality and Quantity of Light
Lighting Calculations
Interior and Exterior Lighting Applications

The program was conducted by the Education Committee of the I.E.S. Section.

Residence Lighting Forum Active in Atlanta

The first fall meeting of the Atlanta Residence Lighting Forum, Monday, October 29, featured illustrated discussions of outstanding papers on residential lighting which were presented at the National Technical Conference in Washington, last August. These presentations were made by Ruth Morris and Elizabeth Parker, Georgia Power Co., and J. Dixon Mitchell, Westinghouse Electric Corp.

Newly elected officers and chairmen of the Forum are:

Chairman — Fern Smeeton, manufacturers' agent
Secretary—Ruth Morris, Georgia Power Co.
Treasurer—Herbert L. Reed, H. C. Biglin Co., Inc.
Members-at-large — Mary George Jimmerson, Noland Co.; Frances J. Black, *Electrical South*, May M. West, vocational teacher.
Ex-officio — sponsor, Judd Lough, Holophane Co., Inc.; past chairman, Emily Alexander, Georgia Power Co.; and the following committee chairmen.
Program Chairman—Amelia Harper
Publicity Chairman—Frances J. Black
Arrangements Chairman—Emily Alexander
Membership Chairman—Mary George Jimmerson
Attendance Chairman—Nina Faye Bonner
Reception Chairman—Mary Lou Edwards

I.E.S. Group Tours New California Laboratories

More than 100 members of the Northern California Section, I.E.S. were conducted on a tour of the new Standards and Illumination Laboratories of the University of California and witnessed demonstrations of the array of precision measurement apparatus in the two laboratories, which are part of the University's new $2,000,000 electrical engineering building, Cory Hall. Professor Finch, head of the new Illumination Laboratory, was host for this tour.

LIGHTING CALENDAR

Society Events

December 13, 1951—Meeting of I.E.S. National Council, New York, N. Y.

January 10, 1952—Meeting of I.E.S. Council Executive Committee.

February 14, 1952—Meeting of I.E.S. National Council, New York, N. Y.

March 13, 1952—Meeting of I.E.S. Council Executive Committee.

March 13-14, 1952—South Pacific Coast Regional Conference, Hotel Sir Francis Drake, San Francisco, Calif.

March 20-21, 1952 — Pacific Northwest Regional Conference, Hotel Victoria, Vancouver, B. C.

March 31, 1952—Meeting of I.E.S. National Council, Chicago, Ill. (Tentative).

April 6-8, 1952—Southwestern Regional Conference, Hotel Tulsa, Tulsa, Okla.

April 20-22 1952—Southern Regional Conference, Hermitage Hotel, Nashville, Tenn.

April 30 - May 2, 1952—Canadian Regional Conference, Hotel General Brock, Niagara Falls.

May 5-6, 1952—Great Lakes Regional Conference, Statler Hotel, Cleveland, Ohio.

May 8, 1952—Meeting of I.E.S. Council Executive Committee.

May 22-23, 1952—East Central Regional Conference, Webster Hall Hotel, Pittsburgh, Pa.

June 16, 1952—Meeting of I.E.S. Council, New York, N. Y.

June 19-20, 1952 — Northeastern Regional Conference, Hotel Preston, Swampscott, Mass.

July 10, 1952 — Meeting of I.E.S. Council Executive Committee.

September 8-13, 1952 — Illuminating Engineering Society, National Technical Conference, Edgewater Beach Hotel, Chicago, Ill.

Industry Events

January 6-12, 1952 — The 4th Pan American Congress of Ophthalmology, Del Prado Hotel, Mexico City.

January 12, 1952 — Independent Electrical Contractors Ass'n Inc., Annual Banquet, Hotel Astor, New York City.

January 14-17, 1952 — Plant Maintenance Show, Convention Hall, Philadelphia, Pa.

January 17-24, 1952—National Housewares & Home Appliances Exhibits, Navy Pier, Chicago, Ill.

January 21-23, 1952—National Electric Sign Ass'n, Convention & Exhibit, Hotel Sherman, Chicago, Ill.

January 21-25, 1952—Winter General Meeting, American Institute of Electrical Engineers, Hotel Statler, New York, N. Y.

January 28-30, 1952—The American Society of Heating & Ventilating Engineers, 58th Annual Meeting, St. Louis, Mo.

February 7-8, 1952—Instrument Society of America, New York Section, 1952 Regional Conference on Power Plant Instrumentation, Hotel Statler, New York, N. Y.

March 3-6, 1952—Institute of Radio Engineers, Convention, Waldorf-Astoria Hotel & Grand Central Palace, New York City.

March 5-8, 1952 — Essex Electrical League, Seventh Annual Electrical Industrial Exposition, Terrace Ballroom, Newark, N. J.

March 10-13, 1952 — National Electrical Manufacturers Ass'n, Edgewater Beach Hotel, Chicago, Ill.

March 22 - April 6, 1952—Chicago International Trade Fair, Navy Pier, Chicago, Ill.

March 24-26, 1952—American Society Mechanical Engineers, Spring Meeting, Seattle, Wash.

April 1-3, 1952 — Edison Electric Institute, Sales Conference, Chicago, Ill.

April 1-4, 1952—Greater New York Safety Council, 22nd Annual Safety Convention & Exposition, Hotel Statler, New York City.

April 28-30, 1952—The Electrochemical Society, Inc., Nat'l Convention, Benjamin Franklin Hotel, Philadelphia, Pa.

April 28 - May 3, 1952 — Chamber of Commerce, Annual Meeting, Washington, D. C.

May 5-7, 1952 — Engineering Institute of Canada, 1952 Annual Meeting, Hotel Vancouver, Vancouver, B. C.

May 6-9, 1952 — Fourth International Lighting Exposition & Conference, Cleveland Municipal Auditorium, Cleveland, Ohio.

June 8-21, 1952—International Organization for Standardization (ISO) General Assembly, Council and a Number of Technical Committees, Columbia University, New York, N. Y.

Week of June 9, 1952—44th Annual Convention, National Association of Electrical Distributors, Atlantic City, N. J.

June 23-27, 1952 — Summer General Meeting, American Institute of Electrical Engineers, Hotel Nicollet, Minneapolis, Minn.

Week of June 23, 1952—American Society for Testing Materials, 50th Anniversary Meeting, Hotels Statler and New Yorker, New York, N. Y.

June 30 - July 2, 1952—Canadian Electrical Association, Annual Convention, Banff Springs Hotel, Banff, Alta.

August 19-22, 1952 — Pacific General Meeting, American Institute of Electrical Engineers, Phoenix, Ariz.

September 8-10, 1952—American Standards Association's Third National Standardization Conference, Museum of Science and Industry, Chicago, Ill.

October 1-3, 1952—Canadian Electrical Manufacturers Association, 8th Annual Meeting, General Brock Hotel, Niagara Falls, Ontario.

October 13-17, 1952—Fall General Meeting, American Institute of Electrical Engineers, New Orleans, La.

October 20-24, 1952—40th National Safety Congress & Exposition of the National Safety Council, Chicago, Ill.

November 10-13, 1952—National Electrical Manufacturers Association, Haddon Hall Hotel, Atlantic City, N. J.

Lighting Education Course Presented by New York Section

Twelve weekly sessions on "Fundamentals of Illumination" constituted a course, co-sponsored by the New York Sections of the I.E.S. and A.I.E.E. The Course Coordinator was H. A. Anderson, Duro-Test Corp.; the three speakers were R. L. Zahour, of Westinghouse Electric Corp.; R. R. Wylie, Sylvania Electric Products, Inc.; L. R. Anderson, General Electric Co. Attendance at the course was 60.

Topics discussed were

Theory of Light and Control
Illumination Terms, Light Distribution Curves
Filament Lamps and Electric Discharge Lamps
Fluorescent Lamps and Auxiliaries
Equipment Design—Fixture Design
Effect of Brightness and Glare
Lighting Requirements—Analysis of Lighting Design
Illumination Computations—Design of Lighting Systems
Light for Production—Industrial Lighting
Light for Selling—Store Lighting
Light for Seeing—Office and School Lighting
Economics of Lighting—Question and Answer Session

School Lighting Clinic Scheduled Three Days in Chicago

A school lighting clinic of major interest to architects and school superintendents is scheduled to be held in Chicago January 30 through February 1st. A particularly fine program is planned, designed to bring to school officials, contractors, architects and others authoritative information on school lighting and construction, featuring top speakers on this subject.

The Clinic will be held at the Chicago Lighting Institute, 37 South Wabash Ave., Chicago, from 9:00 o'clock in the morning, through dinner and the evening. The program, starting January 30 and filling one day, will be repeated, with the same subjects and speakers, on January 31 and February 1. Registration for the three separate days will be according to vocations. Wednesday registration is suggested for school administrators, architects and engineers. Thursday — school administrators, eye and health specialists. Friday — electrical contractors, distributors and representatives from the lighting industry. This division is planned to enable the speakers to plan their discussion more specifically in accordance with the needs and problems of the group in attendance.

Co-sponsors of the Clinic are the Chicago Section of I.E.S. and the Chicago Lighting Institute. Heading the planning committee is Eric H. Church, Benjamin Electric Mfg. Co., Des Plaines, Illinois, who will serve as Chairman on January 31; G. K. Hardacre, of Public Service of Northern Illinois and President of the Chicago Lighting Institute, will be chairman on Friday, February 1.

I.E.S. National Technical Conferences

Dates and locations of the next two National Technical Conferences of the Illuminating Engineering Society are:

September 8-13, 1952 — Edgewater Beach Hotel, Chicago, Illinois

Week of September 14, 1953 — Hotel Commodore, New York, N. Y.

Standardization Conference Held by ASA

The second National Standardization Conference, sponsored by the American Standards Association, was held in New York City October 22-24. Highlights of the program were an address by Dr. D. A. Hulcy, President of the Chamber of Commerce of the United States, who spoke on "Strengthening America Through Standards"; a panel discussion on defense production, sponsored by the American Ordnance Association with a panel of nine military men; a forum on materials conservation; and the presentation of the Howard Coonley Medal to former president Herbert Hoover. The first "Standards Medal" award was made to Paul G. Agnew, consultant with the association.

Electric Color Control Ceiling In New York Lobby

Color lighting as a major feature of the architectural design of a building, has added another "what to see" in the way of unusual lighting effects in New York City. Renovation of the Webb & Knapp Inc. building at 383 Madison Avenue included the installation of a two and three-quarter story glass front lobby which reveals the unique electronic color control ceiling designed by Rollo Gillespie Williams. The installation was unveiled at special ceremonies on the evening of November 13.

The ceiling, visible not only in the lobby but from the street as well, is composed of a Hexcrate (six-inch hexagonal cells) marshalled in honey comb strips lying flat over the elevator loading corridors, and curving upward for two and three-quarter stories over the lobby proper to meet the great street window. This hexcrate ceiling, and the lighting system behind it, is hung from an intricate network of horizontal and vertical channels, the latter following the curve of the hexcrate all the way down.

Changing colored light electronically controlled by the sunlight to provide cool-colored patterns in summer and warm-toned patterns in winter, is diffused through the hexcrate ceiling on the sim-

(Continued on page 11A)

FIRST PRIZE winner in the Member Grade part of the membership campaign is the Rocky Mountain Section. Here the check for the prize is presented to Membership Committee Chairman, J. L. Vanneman by retiring Section Chairman Harold Rankin, while incoming Chairman G. B. Buck, II and National President S. G. Hibben look on.

4 examples: G-E Light Conditioning program now underway in a BIG way!

FEATURED AT HOME BUILDERS' SHOW. Most of the 40,000 people at this year's Atlanta exhibition saw the Georgia Power Company's Light Conditioning demonstration . . . one of the show's outstanding attractions.

SEEN BY THOUSANDS OF CLEVELANDERS. This home, one of 8 sponsored by the Cleveland Electric Illuminating Company, stayed open day and night; attracted thousands of home buyers interested in Light Conditioning.

ATTRACTED MORE THAN 12,000 VISITORS. People in the Metropolitan New York area flocked to see this Light Conditioned house in Closter, N. J. Recipes used included valance lighting in living room and dining room.

PRODUCED REQUESTS FOR 5000 RECIPE BOOKLETS. After seeing Boston Edison's model Light Conditioned living room, guests of the New England Home Show requested over 5000 Light Conditioning booklets.

ALMOST 100 electric service companies have already begun to tie in with General Electric's Home Light-Conditioning Program. More and more lighting equipment suppliers are promoting Light-Conditioning.

Nearly 2 million Light-Conditioning recipe booklets have been distributed. And millions of people have been seeing and reading General Electric's national advertising on Light-Conditioning.

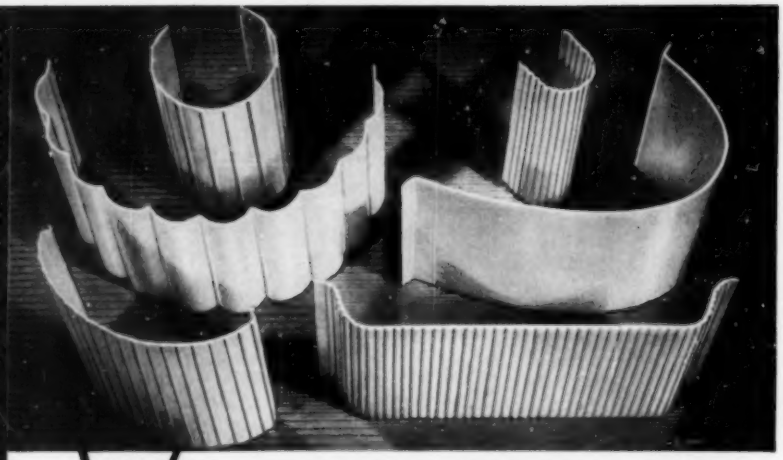
Shown above are four typical examples of how the Light-Conditioning Program is being carried on. To learn how you can tie in, call your G-E Lamp District Office, or write Lamp Division, General Electric, Dept. 166-IE-12, Nela Park, Cleveland 12, Ohio.

You can put your confidence in—

GENERAL ELECTRIC

"POLY-LITE"®

SIDE AND BOTTOM PANELS FOR FLUORESCENT LIGHTING FIXTURES

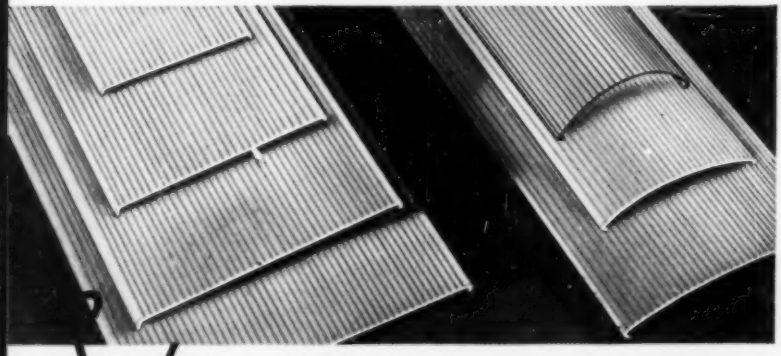


Sandee CUSTOM-MADE FLUORESCENT PANELS

Custom Panels produced to your most exacting specifications with nominal tooling costs. Design, engineering and laboratory facilities at your disposal.

SAVE SAFELY WITH SANDEE PANELS

UNIFORM FULL THICKNESS . . elimination of dangerous overhead weight . . breakage reduction of 80% to 90% . . lower shipping costs (about ⅛ the weight of glass) . . quality that gives long term satisfaction.



Sandee STANDARD FLUORESCENT PANELS

Widths 2" to 6" . . flat or convex uniform radius . . transparent clear or translucent white . . light stabilized . . NO DIE COST!! Write or call for estimates and samples, today.

Sandee MANUFACTURING COMPANY

5050 FOSTER AVENUE, CHICAGO 30, ILLINOIS

WORLD'S LARGEST CUSTOM EXTRUDERS OF PLASTICS FOR ALL INDUSTRIES

(Continued from page 8A)

ple architectural design below. The system can produce fixed patterns of light, constantly changing and fusing patterns, static patterns around which changing patterns can flow, or special effects for certain occasions. The selective controlled lighting system produces over 500 different shades of color at desired levels and for various time cycles that can be automatically pre-set.

Drexel Institute Celebrates Its 60th Anniversary

At the 60th anniversary banquet of Drexel Institute, held in Philadelphia, October 31, I.E.S. was represented by National President S. G. Hibben and P. B. Thorne, Chairman of the Philadelphia Section. On this occasion the top officers of many national technical and engineering societies, together with local organizations, joined with the faculty and alumni of the Institute to get better acquainted, to listen to several addresses stressing the civic duties and moral responsibilities of the engineer. The fact was emphasized that engineering science has traveled far ahead of many advances in the fields of human relations and government, that it now must take part in directing its products to better usage, with higher standings of ethics and responsibilities.

Visual Landing Aids Studied for Standardization

Detailed recommendations for worldwide standardization of visual landing aids at a crucial point in aircraft operation—the short, but vital period between the approach to the runway and the actual "touch down"—are now being studied by the International Air Transport Association (IATA) with a view toward presenting them to governments early next year.

The recommendations provide specifications for approach lighting and lighting and marking of runways and threshold areas at airports. They were agreed upon by a ten-day meeting of the IATA Flight Technical Group at New York from October 16 through 26.

Top-flight pilots and engineers of the international airlines participated in the group's study and evaluation of systems now in operation, as well as of experimental and theoretical data. Experts of the International Civil Aviation Organization (ICAO), of individual governments and of lighting designers and manufacturers took part as observers.

Passing on studies made by previous sessions, the IATA Group concluded that both the Calvert and ALPA (Air Line Pilots Association) systems of approach lighting arrangement generally meet the operational requirements for this form of visual aid. Both, it noted, have been tested operationally and found satisfactory.

E. W. Pike, Assistant to Operations Manager, British Overseas Airways, and chairman of the IATA Group, defined the aim of the recommendations as a further step toward complete "on schedule" airline operations in all types of weather. He said the session had concentrated on visual aids to the pilot, rather than electronic devices, but that the latter would be taken up at future meetings.

After approval by the Technical Committee of the world airline organization, the Group's recommendations will be transmitted to ICAO as suggested standards to be applied by individual governments.

As a basic recommendation, the IATA Group asserted that standardization of visual aids is necessary if airlines are to lower their operating minima—that is, if they are to operate with complete reliability under a wider range of adverse weather. They encouraged the search for further improvements to visual aids, but recommended that any resulting alternations should not cause confusion with standard systems or be proposed for worldwide adoption until they have been widely tested under operational conditions.

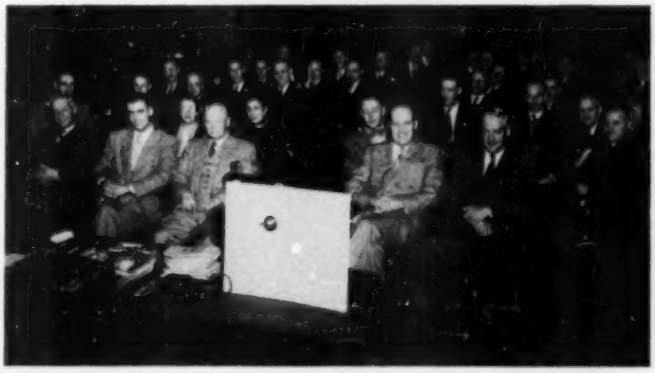
The detailed recommendations cover both lights and markings. Mr. Pike pointed out that while the reasons for lights were well known, the IATA Group felt that marking is especially necessary to serve several major functions: to increase the distance at which the runway can be picked up; to help the pilot judge height and distance along the runway; to give the pilot accurate horizontal plane guidance when he is close to the ground or taxiing; and to give him "roll" guidance when the actual horizon is obscured.

Organizations having observers at the IATA Flight Technical Group meeting at New York included ICAO; the Royal Aeronautical Establishment, Farnborough; Air Navigation Service, French Ministry of Public Works; Australian Department of Civil Aviation; Irish Civil Aviation Department; U. S. Bureau of Standards; the lighting and flight inspection divisions of the U. S. Civil Aeronautics Administration; Royal Netherlands Air Force; U. S. Military Air Transport Service; Air Transport Association of America; Phillips Lamp Works, Netherlands; General Electric Company, England; Sperry Gyroscope Corporation; Westinghouse; and the Flight Safety Foundation.

Solutions to Engineering Shortage Problems Offered

The dwindling supply of American engineers was termed "alarming" by a prominent body of engineers, educators and industrialists during a Convocation held recently in Stephen Foster Memorial (Hall) on the Campus of the University of Pittsburgh. The meeting was arranged by the Engineering Manpower Commission of the Engineers Joint Council and by the Engineers Society of Western Pennsylvania, through its president and acting chairman, G. A. Shoemaker, vice-president of the Pittsburgh Consolidation Coal Co. The convocation was attended by some 600 representatives

(Continued on page 15A)



OPENING MEETING of the 1951-52 year for the Quebec Chapter, I.E.S., was held in the Terrace Room of the Chatean Frontenac. Speaker of the evening was John Harrison of the Toronto Section who gave a talk, with demonstration on "Accurate Light Control with Prismatic Glass."

» TO INSURE TOPS IN

JEFFERSON

For Proper Starting and Operation of Mercury Vapor Lamps

Mercury Vapor Lamps have now proven their unusual *high lighting efficiency and low operating cost.* Being of the gaseous-discharge type they require means of providing the correct starting and safe operating current . . . The Transformers as made by Jefferson Electric perform these functions,—providing the correct voltage and current needed for sure starting—and operation. Without this control, lamp brilliancy and life are adversely affected.

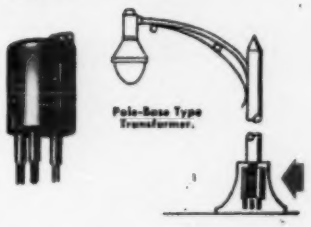
LIGHTING EFFICIENCY

JEFFERSON TRANSFORMERS PROVIDE THESE FEATURES

- Designed to insure proper control of the current characteristics to predetermined specifications, so important to satisfactory mercury lamp operation.
- Flexibility—The same transformers may be used for mounting on a wall or pole—*and by means of the Jefferson-developed Adaptor fit any pole top from 2½ to 4-in. diameter.* Reduces stock to be carried.
- Moisture and weatherproof deep-drawn one-piece galvanized steel case with weatherproof paint finish.
- Liberally designed for long life.
- Types for multiple (normal and high power factor) or series circuits.
- All multiple circuit transformers have three primary voltage taps to closely match the line voltage for best possible lamp operation.
- Traditional Jefferson Quality Throughout.

Transformer for attaching to pole or wall.

Same Transformer fitted to Adaptor for pole-top installation. The Adaptor fits any pipe from 2½-in. to 4-in. diameter.



Pole-Base Type Transformer.

TRANSFORMERS

FOR MERCURY VAPOR LAMPS

This nameplate identifies all Jefferson-designed Transformers—carries all data and connection information.

Made Expressly for Mercury Lamp Operation by Transformer Specialists

For over 35 years Jefferson Electric Transformers have demonstrated the excellence of their design, precision manufacture and long-life dependability. Specialized engineering ability and experience have built a reputation widely acknowledged in the field of so-called "small" transformers.

You can be sure that the operation of your mercury lamps will give you better satisfaction when you install transformers built by Jefferson specialists.

New Bulletin 521-5 contains complete data. We'll be glad to forward a copy on request.

JEFFERSON ELECTRIC COMPANY • Bellwood, Illinois

In Canada: Canadian Jefferson Electric Co., Ltd., 384 Pape Ave., Toronto, Ont.

ACUSTI-LUMINUS CEILINGS

NO NOISE — NO GLARE — EVEN LIGHT EVERYWHERE

Excellent results in both acoustical correction and higher glareless lighting levels were maintained in this office, one of many installations of ACUSTI-LUMINUS CEILINGS.

Quality illumination priced unbelievably low. Non-burning corrugated plastic is suspended at the desired ceiling level on acoustic baffles, behind which continuous rows of fluorescent or slimline furnish the light source.

Installations in over 100 offices, school rooms, drafting rooms, stores, etc. have proven most gratifying. Plastic is easily washed and rewaxed in a specially designed machine, to keep maintenance costs surprisingly low. Unsightly sprinkler pipes, ducts, etc. are hidden without impairing the function of the sprinkling system, or increasing fire insurance rate.

SEND FOR ADDITIONAL INFORMATION.

A FEW TERRITORIES ARE STILL OPEN FOR QUALIFIED LIGHTING ENGINEERS IN THIS MOST PROMISING NEW FIELD

LUMINOUS CEILINGS INC.

2500 WEST NORTH AVENUE
CHICAGO 47, ILLINOIS

(Continued from page 11A)

of American industry, the engineering profession, college educators, and Pittsburgh secondary schools.

Educational efforts of the discussions were highlighted by Dean Hollister when he showed on a chart that the 1951 need for engineers comes to 95,000 to satisfy industry and the military. But only 38,000 were graduated from colleges this year. He stated, and suggested two four-point programs to be immediately put into use by industry and the military in order to help meet the demand.

Dr. Trytten who beamed his opinions at the military in misplacing engineering personnel once they are in the various services, stated that there needs to be a clear understanding of the need for properly trained people at each important station, regardless of where it is, whether it be at the front or rear and regardless of the type of training that may be necessary. "Similarly," he added, "there needs to be a provision made so that those who serve in one position required by the national interest be not stigmatized in comparison with others who serve in other capacities equally important to the national interest."

The engineering profession itself was called upon by Carey H. Brown to "broadcast" the facts as to the shortage of engineers and to disseminate this information to their own local communities. He outlined a broad program for the general engineering profession to follow in the enrollment of new personnel. "If America is to be the arsenal of democracy, we must out-design and out-produce our enemies." He enlarged upon the engineer's role in coping with this shortage and asserted that, to properly play his part, each individual engineer must so devote himself to his own task that the total engineering output shall not suffer by his deficiency.

Also outlined was a program for the utilization and strengthening of the engineering profession for the guidance of the military. The military establishment was cautioned not to call those in critical engineering positions without due regard for the importance of their present service. They should be assigned to duties applicable to the involving full-capacity use of their engineering training and experience. Enlisted and Officer reservists whose training qualifies them as engineers should be used in assignments only engineers can fill.

Simultaneously, industry was urged to use engineers in jobs in which engineers only are required, and not to hold young engineers in "intern" positions longer than necessary to qualify them. Finally, engineers should be moved to positions of maximum responsibility, and released from positions not requiring engineering training.

The Engineering Manpower Commission said the pattern of utilization of engineers must be greatly modified, if vitally necessary engineering work is to be accomplished with the limited numbers available. Delegations of engineers from other areas throughout the country who were also present, were there to learn of the programs developed by EMC to combat the problems created by the critical shortage of engineers.

OBITUARIES

Stanley P. Ecclestone, president of the Public Lighting Commission of Detroit, died November 11. In addition to membership in the Michigan Section, I.E.S., Mr. Ecclestone was president of the Electrical Association of Detroit, a member of Engineering Society of Detroit, Electrical Manufacturers Representatives Association, Industrial Electrical Engineering Society. He was president of S. P. Ecclestone & Sons.

Charles A. Lehman, active member of the New York Section, I.E.S., and member of its board of managers, died unexpectedly November 5 of haemorrhage in the heart. Commercial Sales Manager of the Staten Island Edison Corp., Mr. Lehman has been actively engaged in lighting work since 1935. In addition to his interest in the I.E.S., he was on the National Committee of the Edison Electric Institute.

ABOUT PEOPLE

Two active I.E.S. members have recently joined Unistrut Products Co. **Brad Fogarty** has been appointed district manager for the company's new Southeastern District sales offices and warehouse at 1321 Spring Street, N. W., Atlanta, Georgia. Mr. Fogarty was formerly southeastern sales manager for the Lighting Division of Sylvania Electric Products, Inc. **W. J. Raleigh**, also an I.E.S. member, has joined the same firm to serve in an executive sales capacity in the home office in Chicago.

To provide additional service for the members and employers organizations throughout Ontario, **Thomas C. Keefer** has been appointed as field secretary to the executive administration staff of the Ontario Association of Professional Engineers.

A new branch warehouse has been opened by General Electric's Lamp Division, with **Richard Creighton** in charge. The warehouse, located at 635 Cedar Street, Charlotte, N. C., will serve the Carolinas Sales District, **G. E. Park**, manager.

Frank J. Matusek has been transferred from the Atlantic Sales District of General Electric's Lamp Division to Nela Park headquarters. In his new work, Mr. Matusek will serve as photo and miniature lamp specialist in the resale field.

Harold A. Cooch was recently elected president of the Canadian Electrical

(Continued on page 17A)

I.E.S. Regional Conferences, 1951-1952

Region	Place	Date
South Pacific Coast	Sir Francis Drake Hotel San Francisco, Calif.	March 13-14
Pacific Northwest	Victoria, B. C.	March 20-21
Southwestern	Hotel Tulsa Tulsa, Okla.	April 6-8
Southern	Hermitage Hotel Nashville, Tenn.	April 20-22
Canadian	General Brock Hotel Niagara Falls, Ont.	April 30 - May 2
Great Lakes	Statler Hotel Cleveland, Ohio	May 5-6
East Central	Webster Hall Hotel Pittsburgh, Pa.	May 22-23
Northeastern	Hotel Preston Swampscott, Mass.	June 19-20

it takes QUALITY, CRAFTSMANSHIP and VIGILANCE to finish better fluorescent fixtures...

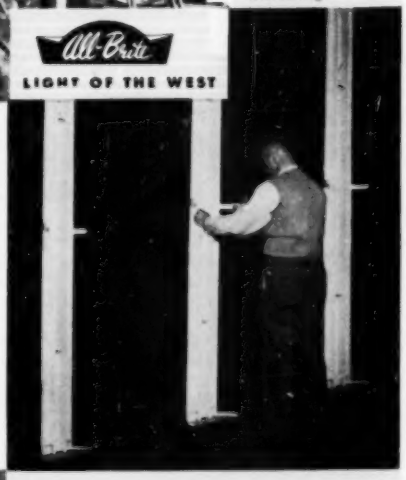
WE USE OUR OWN FORMULA 44X HIGH-REFLECTANCE BAKED ENAMEL!

extreme left: Every All-Brite spray painter is an artist-craftsman who excels in applying fine enamels.

center: Three spray painters are assigned to this All-Brite spray booth. Result: perfect paint coverage.

below: Fixtures are severely inspected during every stage of finishing before and after baking.

All-Brite
LIGHT OF THE WEST



...and we know how to apply it!

Behind the smooth, tough and long-lasting finish on ALL-BRITE luminaires is a combination of quality materials and advanced methods for metal preparation and spray-enamel application. Fully 400 feet of continuous conveyor carries parts past critical inspectors thru every stage of the process. Scientifically engineered packaging for every All-Brite model protects the fixture and its finish until it reaches you.

FLUORESCENT FIXTURES OF CALIFORNIA

THREE ALL-BRITE PLANTS:

san francisco: 3320 - 18TH ST.
los angeles: 613 IMPERIAL ST.
portland: 1318 S. W. FIRST AVE.

(Continued from page 15A)

Manufacturers Association at its annual meeting. Mr. Cooch is chairman of the board of the Canadian Westinghouse Company, Ltd., Hamilton, Ontario.

William C. Kappler has been appointed superintendent of miniature lamp manufacturing for Westinghouse Electric Corp. Mr. Kappler has been general foreman of the department since 1949.

The appointment of **Frederic J. Robinson** as Director of the International Sales Division of Sylvania Electric Products, Inc., was recently announced. Mr. Robinson has been the company's sales manager for the Latin America countries since 1943.

General Electric's Lamp Division is building a new sales and service headquarters at 2800 N. W. Nela St., Portland, Ore. The headquarters will house the offices of the North Pacific Sales District, **C. A. Rost**, manager, and the Portland Service District, headed by **A. C. Ham**.

BOOKS AND PAMPHLETS

*Books whose reviews are marked * are available for inspection at Headquarters Office, Technical Department*

***Light, Photometry and Illuminating Engineering** by William E. Barrows. Third Edition published 1951 by McGraw-Hill Book Co., Inc., New York; 415 6 x 9 inch pages, 309 illustrations, 65 tables; price $7.50.

Approximately two-thirds of the material in this modernized version of a standard text are new or completely revised since the 1938 edition. Chapter headings include: light and vision; photometric standards, units and nomenclature; sources of light; gas, vapor, and fluorescent lamps; principles of photometry and photometers; photometric measurements and illumination surveys; light-flux calculations and spherical photometry; principles of interior lighting; illumination calculations and design; light control and application; interior lighting practice; lighting for sports and recreation; principles of street and highway lighting; and lighting streets, highways, and airways. Six pages of problems conclude the volume.

The author is Professor Emeritus of Electrical Engineering at the University of Maine. His first lighting text was produced in 1908 while he was teaching illuminating engineering to electrical engineering students at Armour Institute (now Illinois Institute of Technology). This was followed by a second text in 1912 and the first edition under the current title in 1925.

***Electric Illumination** by John O. Kraehenbuehl, Second Edition, published by John Wiley & Sons, New York, 1951; 456 5⅝ x 10 inch pages, 153 illustrations; price $8.00.

The second edition of this well-known volume incorporates the changes and new developments which have occurred in the lighting field since the publication of the first edition nine years ago. The first edition was widely used by engineers in the field as well as a textbook in both electrical engineering and architectural classes. It is a practical text with much reference material. New features include illumination calculations with line and surface sources and louverall ceilings.

The author is Professor of Electrical Engineering at the University of Illinois and a Fellow Member of the Illuminating Engineering Society.

***Manual for the Illuminating Engineer on Large Size Perfect Diffusors** by H. Zijl, published 1951 by N. V. Philips Gloeilampenfabrieken, Eindhoven, Netherlands; available in U. S. from Elsevier Press Co., Inc., 402 Lovett Blvd., Houston, Texas; 270 6 x 9 inch pages, 120 illustrations, 49 graphs, many tables; price $4.25.

Illuminating engineers are increasingly tending, for good optical reasons, to use diffused light sources of considerable size; indeed, the dimensions of a source for a given purpose will often exceed the distance from the reference plane. For both practical and decorative purposes, wide use is being made of glass panels lit from behind, and of rows of tubular lamps and similar sources, for calculating the effects of which no simple method exists. The same applies to daylight illumination, which also falls outside the scope of the simple inverse square law and the cosine law.

This volume is a survey of the problems of light distribution for diffuse emitters of both finite and infinite dimensions. The mathematical formulae recommended for practical use are clearly set out, and for those who demand the theoretical basis, the author shows how they are derived, and thus indicates the way to further study. The object is to collate the knowledge which is scattered in the literature, and to improve on the empirical and haphazard methods too often used.

Features of the book include: a set of 49 charts from which illumination values produced by diffuse light sources of different types and dimensions can be computed directly, a set of coefficient of utilization tables to be applied in computing modern installations for general lighting, a new method for computing the sky-factor in daylight engineering, and a rule of thumb which brings most of the problems relating to large light sources within the scope of the simple inverse square law and cosine law. Mathematical treatment never exceeds simple applications of calculus, so that the book is likely to be of interest to most trained electrical engineers, photographic scientists, architects and others concerned with the problems of efficient illumination.

Defense Production Record, the official weekly bulletin of the Defense Production Program, is available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. at $2.50 per year ($4.00 foreign). Purpose of the magazine is to provide a concise, explanatory record of all official actions of the Defense Production Administration and related Federal agencies; to interpret and explain the need for and purpose of such actions and to present other factual information on defense production.

NEW MEMBERS

At the meeting of the Council Executive Committee held in New York City on November 15, 1951, the following were elected to membership:

ALAMO CHAPTER

Associate Members:
Covington, F. A., Jr., Post Engineers, Ft. Sam Houston, Texas
Davis, G. B., The Perry Shankle Co., San Antonio, Texas
Roberts, J. H., NuRo Co., San Antonio, Texas
Turpin, R. G., Sylvania Electric Products Inc., Dallas, Texas

ARIZONA CHAPTER

Associate Member:
Keyfauver, B. F., Graybar Electric Co., Inc., Phoenix, Ariz.

BRITISH COLUMBIA SECTION

Associate Members:
Evans, S. B., The T. Eaton Co., Ltd., Vancouver, B. C.
Robinson, Robert, T. Eaton Co., Ltd., Vancouver, B. C.

CAPITAL SECTION

Associate Member:
Rugo, A. J., Sylvania Electric Products Inc., Alexandria, Va.

CENTRAL NEW YORK SECTION

Member:
Platt, N. L., St. John & Platt, Binghamton, N. Y.
Associate Member:
Tallman, R. B., R. D. #1, Ithaca, N. Y.

(Continued on page 36A)

COMMITTEES

COMMITTEES 1951-1952

Except as noted below, all committees are appointed by the President, subject to approval of the Council, and terminate at the time of the first Council meeting each new administration, in the month of October. The duties of each committee are indicated.

S. G. Hibben, President, ex-officio member of all committees.

STANDING COMMITTEES

BOARD OF FELLOWS — To evaluate the eligibility of candidates for transfer to the grade of Fellow and recommend their election by Council.

Ward Harrison, Chairman, 23475 Stanford Road, Cleveland, Ohio

A. A. Brainerd — E. F. Lowry
Paul H. Goodell — G. F. Mudgett
J. L. Stair

COUNCIL EXECUTIVE — To conduct the affairs of the Society between Council meetings.

S. G. Hibben, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

R. F. Hartenstein — A. H. Manwaring
C. C. Keller — E. M. Strong

FINANCE — Direct supervision of the financial affairs of the Society, present annual report on its financial condition and make recommendations to Council as to investments of money and upon all specific appropriations.

M. N. Waterman, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

W. Warren Booth — R. F. Hartenstein
G. J. Taylor

GENERAL BOARD OF EXAMINERS — Evaluate the eligibility of applicants for admission to membership or transfer to the grade of Member and submit to Council their nominees for elections to the grade of Member Emeritus.

E. M. Fahey, Chairman, Public Service Electric & Gas Co., 80 Park Place, Newark N. J.

George S. Evans — Theo. O. Jorgensen

MEDAL AWARD — To consider qualifications of candidates for I.E.S. Medal; submit recommendations to Council and prepare citation for the award.

Howard L. Wright, Chairman, Curtis Lighting of Canada, Ltd., 195 Wicksteed Ave., Leaside-Toronto, Ont.

E. C. Crittenden — J. L. Stair
C. H. Goddard — Walter Sturrock
G. K. Hardacre — Lee E. Tayler
M. Luckiesh — J. M. Walsh

PAPERS — To procure, review and approve all technical papers and discussions thereof, for presentation before National Conferences of the Society.

L. E. Barbrow, Co-Chairman, National Bureau of Standards, Washington, D. C.

Roy Palmer, Co-Chairman, Duke Power Co., Power Bldg., Charlotte, N. C.

R. M. Zabel, Co-Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

PUBLICATIONS — To be responsible for the procurement, review and approval of all material for the publications of the Society other than technical papers approved by the Papers Committee for presentation at National Conferences of the Society and their discussions and committee reports, for which it will have publication responsibility only. Shall also be responsible for the editing, printing and business management of the publications of the Society.

E. C. Huerkamp, Chairman, Westinghouse Electric Corp., 1216 W. 58th St., Cleveland, Ohio

J. M. Stedman, Vice-Chairman, Pennsylvania Power & Light Co., 901 Hamilton St., Allentown, Pa.

Eric H. Church

Sub-Committee on Advertising Sales
J. M. Stedman, Chairman, Pennsylvania Power & Light Co., 901 Hamilton St., Allentown, Pa.

Sub-Committee on Editorial Content
H. H. Magdsick, Chairman, General Electric Co., Nela Park, Cleveland, Ohio

Sub-Committee on Publications Sales
R. W. McKinley, Chairman, Pittsburgh Corning Corp., 307 Fourth Ave., Pittsburgh, Pa.

Sub-Committee on Home Lighting Data Sheets
Edith Buchholtz, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

Sub-Committee on Technical Data Sheets
Eric H. Church, Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

GENERAL COMMITTEES

ADVISORY BOARD ON COMMITTEE PERSONNEL — To examine the organization, accomplishments, and assignments of committees and prepare not later than June 1st of each year a proposed list of committees and personnel.

E. M. Strong, Chairman, Cornell University, Ithaca, N. Y.

C. L. Crouch — A. D. Hinckley
C. H. Goddard — Walter Sturrock

BOARD OF NOMINATION — To prepare a nomination ticket containing the names of those who are deemed best suited to serve as officers and directors in positions to be filled at the ensuing election.

Lee E. Tayler, Chairman, Detroit Edison Co., 1911 First St., Detroit, Mich.

C. H. Goddard — Walter Sturrock
(With Section Representatives)

CONSTITUTION AND BY-LAWS — To prepare for Council amendments to the Constitution and By-Laws as required, and to develop rules of procedure for the operation of the Society.

G. K. Hardacre, Chairman, Public Service Co. of Northern Illinois, 72 W. Adams St., Chicago, Ill.

W. V. C. Foulks — Hoyt P. Steele
Charles N. Laupp — Walter Sturrock
M. N. Waterman

COORDINATING COMMITTEE FOR DEFENSE — To contact various Government Agencies concerned with National Security suggesting cooperation and participation in specific projects as an aid to solution of their problems. Recommending the placement of lighting study projects in present committees or the appointment of study project committees to the Society President and to expedite such study projects and guide accepted reports into proper Government channels.

A. F. Wakefield, Co-Chairman, The F. W. Wakefield Brass Co., Vermilion, Ohio
Major G. D. Mills, Co-Chairman, Department of National Defense, New Army Bldg., Ottawa, Ont.

J. W. Bateman — H. R. Jones
H. R. Blackwell — Paul Manchester
O. P. Cleaver — K. M. Reid
C. L. Crouch — John S. Walsh
S. L. Drumm — M. N. Waterman

Sub-Committee on Artificial Moonlight Project
L. M. N. Bach, Chairman, Tulane University, New Orleans, La.

Mason Guillory — Robert Long
C. J. Sperry

HISTORICAL — To assemble and make available for current reference and to prepare in suitable and durable form for posterity, such historical facts, printed memorabilia, photographs, voice records, museum specimens and allied items as may be judged worthy of composing a continuing digest of the record of the Society's history.

L. H. Graves, Chairman, Curtis Lighting Inc., 230 Park Ave., New York, N. Y.

George Ainsworth — V. R. Lansingh
R. B. Burton, Sr. — Mrs. W. F. Little
H. B. Dates — Lee E. Tayler
Leo Dolkart — George H. Stickney

LIGHTING AND ARCHITECTURE — To plan an interchange of knowledge and data between the architectural profession and the I.E.S.

W. M. Potter, Chairman, General Electric Co., Nela Park, Cleveland Ohio

H. Creston Doner — Douglas Maier
Ray Hurley — Oscar W. Meissner
Lucian T. Kight — Arthur H. Molitor
J. F. Watkins

LIGHTING SERVICE — To stimulate the discussion and practical application of lighting recommendations, standards, test procedures and other technical and scientific data developed by the Society to regional and local committees and to conduct a Lighting Service Forum in connection with the National Technical Conference.

Lee E. Tayler, Chairman, The Detroit Edison Co., 2000 Second Ave., Detroit, Mich.
Committee to be appointed.

LOCAL ACTIVITIES — To coordinate regional and local activities with the national program of the Society, assist Section and Chapter officers with local operating problems, conduct Local Activities Conferences, prepare plans to give members a better understanding of the Society, review applications for the establishment of new Sections and Chapters and recommend the appointment of local representatives.

A. H. Manwaring, Chairman, Philadelphia Electric & Mfg. Co., 1226 N. 31st St., Philadelphia, Pa.

W. E. Folsom — F. P. Labey
Paul H. Hildebrand — C. O. Martin
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(Continued on page 21A)

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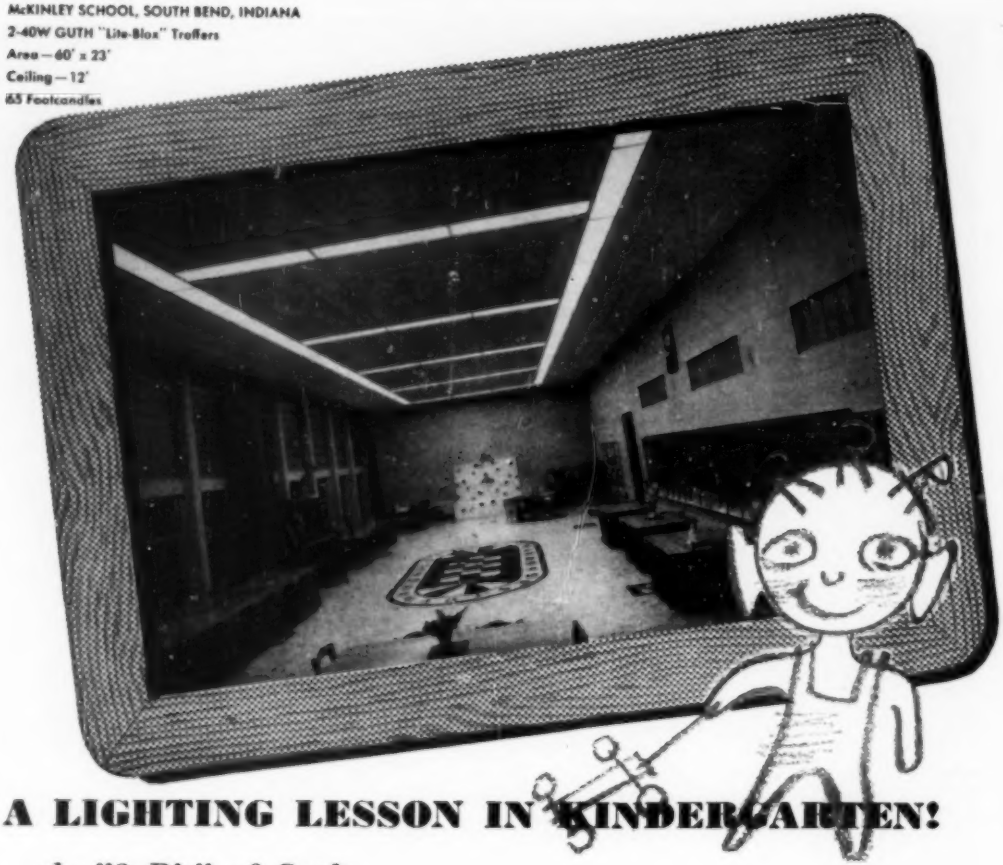

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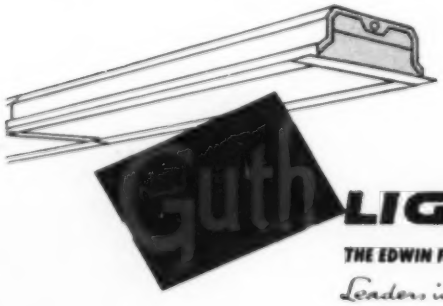

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(Continued from page 18A)

MEMBERSHIP — To develop plans and supervise the operation of the individual membership campaign in the Society.

R. G. Slauer, Chairman, Sylvania Electric Products, Inc., 60 Boston St., Salem, Mass.

Regional Chairmen

Lloyd W. Crotzer
Others to be appointed.

Section and Chapter Representatives

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Thomas Bjorge	William R. Major
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Leo E. Chaffin	John Noyes
J. R. Clucas	H. W. Nussbaum
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E. J. Copland	Frank R. Sandy
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Walter H. Garrett, Jr.	Robert J. Welch
E. D. Heintze	D. A. Wismer
V. E. Hendrickson	Harold R. Young

NATONAL TECHNICAL CONFERENCE — To supervise the 1952 Technical Conference, select the time and place for the 1954 Technical Conference and act as a depository of invitations for future conferences; study and report to Council the possibility of holding periodically a nationally sponsored technical conference for the Pacific Coast Zone.

Heyt C. Steele, Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

George W. Clark	Ralph G. Raymond
J. C. Forbes	R. G. Slauer
R. F. Hartenstein	Lee E. Tayler
A. D. Hinckley	A. S. Turner, Jr.
Charles N. Laupp	M. N. Waterman
C. B. Pederson	R. M. Zabel

Conference Executive Committee

Ralph G. Raymond, Chairman, Commonwealth Edison Co., 72 N. Adams St., Chicago, Ill.

C. P. Pederson, Vice-Chairman, Illinois Bell Telephone Co., 208 W. Washington St., Chicago, Ill.

Glenn G. Boyd

PROCEDURES AND POLICIES — Analyze for Council current procedures and policies and make recommendations.

Duncan M. Jones, Chairman, Curtis Lighting Co. of Canada, Ltd., 19 Ballantyne Ave., Montreal, Que.

George R. Baumgartner	C. H. Goddard
G. W. Beals	Dana W. Rowirn
George S. Evans	Hoyt P. Steele

Lee E. Tayler

PUBLIC RELATIONS AND INFORMATION — To prepare and disseminate information about the activities, accomplishments, programs, objectives and policies of the Society and about the place of illuminating engineering in modern society; to formulate and submit public relations policies and plans for the Society.

J. S. Schuchert, Chairman, Duquesne Light Co., 435 Sixth Ave., Fittsburgh, Pa.

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Berlon C. Cooper	John H. Ronayne
H. H. Green	G. B. Roscoe
L. A. Hobbs	C. C. Shotwell
James Krieger	R. G. Slauer
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Frances Black	Jay Meara
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Paul E. Keys	Edwin H. Voss
Roy H. Kreyser	George A. Watters
Arthur P. Larson	Thomas J. Whalen
Henry Lushington	Darcie H. White
R. W. Lyon	Edward R. White
Brett G. Manlove	C. S. Witcher

RESIDENCE LIGHTING FORUMS — To reactivate and expand residence lighting forums, suggest programs for meetings, revise Guide for Residence Lighting Forums, and conduct a National Residence Lighting Forum Conference in connection with the National Technical Conference.

Jan Reynolds, Chairman, Sylvania Electric Products, Inc., 1740 Broadway, New York, N. Y.

Jacob Blitzer	Caroline E. Horn
Mary E. Dodds	Robert R. Lusk
Lillian E. Eddy	Ruth Morris
Myrtle Fahsbender	Priscilla Presbrey
Mary Love Gale	Margaret Salter

Mary Taepke

SUSTAINING MEMBERSHIP — To obtain additional Sustaining Members.

C. C. Shotwell, Chairman, Philadelphia Electric Co., 1000 Chestnut St., Philadelphia, Pa.

Paul F. Kauffman	Walter Wildeman

Section and Chapter Representatives

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Edward H. Grieb	L. C. Twitchell
Robert H. Hamilton	Don F. Varner
Elbert A. Hawkins	J. M. Wickett
George M. Hooks	Donald D. Wood

P. M. Wood

TASK COMMITTEES

TASK COMMITTEE ON ADVANCE PLANNING — To study the operation, program, publication activities, membership classifications and financial structure with a view of its immediate and long-range objectives and to make recommendations to Council.

C. C. Keller, Chairman, Holophane Co., 342 Madison Ave., New York, N. Y.

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Duncan M. Jones	E. M. Strong
A. H. Manwaring	M. N. Waterman

J. F. Whitehead, Jr.

TRUSTEES, I.E.S. HEADQUARTERS RETIREMENT PENSION PLAN

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R. F. Hartenstein	Walter Sturrock

Marshall N. Waterman

TECHNICAL COMMITTEES

AVIATION LIGHTING — To study the application of light and lighting to the spaces and functions involved in the operation of aircraft.

R. C. Blatt, Chairman, McGraw-Hill Publishing Co., 330 W. 42nd St., New York, N. Y.
D. C. Miller, Secretary

Committee listing to be published in later issue.

CIVIL DEFENSE, LIGHTING FOR — To appraise and report on special lighting problems connected with emergency military operations that directly involve civilian defense and protection, such as equipment for bomb shelters, special street and vehicular lighting, mobile self-contained lighting facilities for use in bombed areas, and emergency lighting devices and visual aids to movement in the event of power failure.

L. J. Schrenk, Co-Chairman, Public Lighting Commission, 174 Atwater St., E., Detroit, Mich.
J. W. Bateman, Co-Chairman, Canadian General Electric Co., Ltd., 165 Dufferin St., Toronto, Ont.
Harry Grattan, Vice-Chairman, Potomac Electric Power Co., 10th & E Sts., N. W., Washington, D. C.
John Walsh, Secretary

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W. F. Little	T. H. Shepherd

H. E. Stafford

Lighting Advisors for the East Coast

J. C. Forbes, Chairman, General Electric Co., 570 Lexington Ave., New York, N. Y.
Paul Manchester, Vice-Chairman, Blackstone Valley Gas & Electric Co., 55 High St., Pawtucket, R. I.

E. T. Diggs	Roy A. Palmer
S. L. Drumm	R. P. Teele
R. M. Hoot	Frank Wyatt

COLOR AND ILLUMINATION — To study, evaluate and report on the effect of color in relation to the art and science of illumination.

Ralph M. Evans, Chairman, Eastman Kodak Company, 65 Kodak Park, Rochester, N. Y.

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A. A. Brainerd	W. H. Kahler
L. H. Brown	J. C. Kromhout
E. W. Commery	H. L. Logan
C. L. Cottrell	Norman Macbeth
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G. F. Dean	Gladys Miller
Dean Farnsworth	Dorothy Nickerson
Carl E. Foss	S. W. Quisenberry
W. C. Granville	Frederick Rahr
J. P. Guilford	D. E. Spencer

Kenneth C. Welch

DAYLIGHTING — To study the problems involved in daylighting, develop recommended practices and report thereon.

R. L. Biesele, Jr., Chairman, Southern Methodist University, Dallas, Texas

W. J. Arner	J. A. Meacham
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H. S. Bull	R. A. Miller
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O. F. Wenzler

FARM LIGHTING *(Formerly Farm Buildings and Work Area Lighting)* — To study the application of light and lighting of farm buildings, surrounding work areas and other rural locations and to report thereon.

(Continued on Page 22A)

(Continued from page 21A)

P. H. Hildebrand, Chairman, Pennsylvania Power & Light Co., 9th and Hamilton Sts., Allentown, Pa.

T. M. Barr	O. D. Hunt
Edith Buchholtz	Arthur Kramer
J. P. Ditchman	Joseph Schaenzer

A. J. Von Burg

HANDBOOK REVISION — To revise and arrange the technical content of the Handbook; to lay out, plan and arrange for development of individual sections primarily through appropriate technical committees; to establish and maintain liaison with the Publications Committee with reference to production matters and the preparation of a budget which will be submitted by the Publications Committee to Council for approval; to be responsible to Council for the technical accuracy and treatment of material to be turned over to the Publications Committee for publication.

B. J. Jensen, Chairman, Public Service Electric & Gas Co., 80 Park Place, Newark, N. J.

Willard Allphin	G. G. Rae
C. L. Cottrell	J. L. Tugman
D. M. Jones	M. N. Waterman

ILLUMINATION PERFORMANCE RECOMMENDATIONS — To prepare illumination performance recommendations for luminaires conforming to I.C.I. classifications, excluding residential.

Ray P. Teele, Chairman, National Bureau of Standards, Connecticut Ave. and Van Ness St., N. W., Washington, D. C.

B. S. Benson, Jr.	W. F. Little
S. K. Guth	J. F. Parsons
W. H. Kahler	G. P. Wakefield

INDUSTRIAL LIGHTING — To revise the 1942 "American Recommended Practice of Industrial Lighting" with full consideration to the brightness approach, and with Council approval, to submit for American Standards Association approval.

W. C. Brown, Chairman, General Electric Co., Nela Park, Cleveland, Ohio
E. A. Linsday, Secretary

G. W. Beals	D. J. O'Neill
W. E. Folsom	D. W. Patterson
W. H. Kahler	C. C. Shotwell
Harry F. Keene	H. P. Steele
W. P. Lowell, Jr.	J. W. Steiner

M. N. Waterman

LIGHT CONTROL AND EQUIPMENT DESIGN — Collect and correlate the knowledge and data on means and methods of controlling, directing, reflecting, transmitting and diffusing light and on the principles and practices of equipment design.

R. D. Bradley, Chairman, Day-Brite Lighting, Inc., 5411 Bulwer St., St. Louis, Mo.
David L. Williams, Vice-Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

G. R. Baumgartner	M. P. Morse
B. S. Benson, Jr.	Franklin M. Neal
Kurt Franck	C. N. Sprankle
G. C. Moore	F. C. Winkler

LIGHTING AND AIR CONDITIONING — To study the relationship between lighting and various factors that enter into air-conditioning and report thereon.

E. H. Salter, Chairman, Electrical Testing Laboratories, Inc., 2 East End Ave., New York, N. Y.

Samuel A. Bogen	Louis Mueller
R. R. Lusk	Howard M. Sharp

Representatives for American Society of Heating & Ventilating Engineers

M. C. Beman	J. N. Livermore

B. G. Priester

LIGHTING DESIGN PRACTICE — To study published data on coefficients of utilization, room indexes, maintenance coefficients and other elements entering into calculations for lighting design, develop standard methods for use in Society publications and report thereon.

Neal Jacobus, Chairman, Sylvania Electric Products Inc., 407 Jackson Building, Buffalo, N. Y.

Charles Amick	J. O. Kraehenbuehl
B. S. Benson, Jr.	J. J. Neidhart
J. H. Dean	J. F. Parsons
J. R. Jones	E. H. Salter

Howard Sohn

LIGHTING EDUCATION — To prepare educational and training programs on the fundamentals of illumination, lighting design problems and advance theories of light and lighting application. To prepare required text material and to further their adoption locally.

C. E. Weitz, Chairman, General Electric Co., Nela Park, Cleveland, Ohio

B. S. Benson, Jr.	Robert Ligare
Warren B. Boast	R. R. Lusk
E. L. Dodington	C. D. Miller
S. K. Guth	W. E. Miller
O. D. Hunt	J. F. Parsons
W. B. Kennedy	H. A. Stroud
E. K. Kraybill	D. C. White
Carter Lewis	Robert S. Wiseman

Joint Sub-Committee I.E.S.-U.S. Public Health Service

J. F. Parsons, Chairman, Niagara Mohawk Power Corp., 802 Electric Building, Buffalo, N. Y.

B. S. Benson, Jr.	Neal Jacobus
L. J. Cahill	Mrs. Tula Brocard
George Clayton	Arthur Koven

LIGHTING OF CENTRAL STATION PROPERTIES — To study and report on the lighting of electric power generating plants and their power distribution facilities.

R. W. Corwin, Chairman, Benjamin Electric Mfg. Co., 230 W. 17th St., New York, N. Y.

A. A. Brainerd	R. M. Graves
R. S. Bucher	Paul E. King
Hugh Carroll	Carter Lewis
H. A. Cook	W. S. Mowry
H. E. D'Andrade	D. J. O'Neill
V. L. Dzwonczyk	L. G. Parks
C. E. Egeler	C. B. Stephens

D. W. Taylor

LIGHTING STUDY PROJECTS IN INDUSTRY — To initiate, follow up and coordinate lighting study projects in the industrial field, review the reports of the various sub-committees in this field and make recommendations to Council.

A. A. Brainerd, Chairman, Philadelphia Electric Co., 1015 Chestnut St., Philadelphia, Pa.

J. R. Chambers	Shirley Huse
C. E. Egeler	W. H. Kahler
C. D. Hollister	W. P. Lowell, Jr.

J. P. Parks

Lighting in the Canning Industry

Carl O. Martin, Chairman, Benjamin Electric Mfg. Co., 829 Folsom St., San Francisco 7, Calif.

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S. H. Hazleton, Jr.	Robert Thallon
K. M. Noble	David C. White

H. K. Wilder

Lighting in Foundries

Frank E. Mueller, Chairman, 1296 Nicholson, Lakewood 7, Ohio

C. W. Briggs	C. E. Egeler
A. L. Collier	J. H. Lansing

J. W. Steiner

Lighting in Laundries

O. A. Hill, Jr., Chairman, Public Service Co. of No. Illinois, 1701 S. First Ave., Maywood, Ill.

G. F. Allen	Carl F. Jensen
J. R. Chambers	R. R. Lusk
A. L. Christensen	W. S. E. Miller
R. R. Hill	A. A. Sobolik

Lighting in Sheet Metal, Stamping, Folding and Shearing Industry

Floyd W. Sell, Chairman, The Detroit Edison Co., 2000 Second Ave., Detroit 26, Mich.

Howard A. Boltz	J. M. Marlin
E. L. Frase	Ted Roughley

Lighting in Steel Mills

A. Paulus, Chairman, Westinghouse Electric Corp., 337 Blvd. of Allies, Pittsburgh, Pa.

J. J. Booth	H. Hargest
C. M. Crysler	Lucian T. Kight
C. J. Englind	H. J. Mazur

Carlton Ostrom

Supplementary Lighting

W. H. Kahler, Chairman, Westinghouse Electric Corp., 1216 W. 58th St., Cleveland 2, Ohio

G. F. Dean	E. A. Linsday
L. E. Goble	R. A. Mousk

Lighting in the Textile Industry

W. L. Kelley, Jr., Chairman, 77 Bayley St., Pawtucket, R. I.
J. M. Shute, Vice-Chairman, Bachman Uxbridge Worsted Corp., Uxbridge, Mass.
F. J. Vorlander, Jr., Secretary

L. S. Cooke	Benjamin F. Roth
John S. Dickson	Carl E. Rydman
L. A. Kline	F. E. Singleton
Walter P. Rayner	J. E. Watkins

LIGHTING STUDY PROJECTS IN PUBLIC BUILDINGS AND PRIVATE INSTITUTIONS — To initiate, follow up and coordinate lighting study projects in the field of public buildings and private institutions, review the reports of the various study sub-committees in this field and make recommendations to Council.

Robert S. Rogge, Chairman, 9117 Prevost Ave., Detroit 28, Mich.

L. V. James	J. M. Ketch
J. R. Jones	A. C. Sangster

C. C. Shotwell

Lighting in Auditoriums and Churches

Edward Rambusch, Chairman, Rambusch Decorating Co., 40 W. 13th St., New York, N. Y.

Louis Gold	David H. Mason
H. C. Jones	C. W. McCormick
Wm. B. Kennedy	Paul V. Funk
L. D. Lyon	L. W. Saltz

Lighting in Hospitals

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J. C. Conner	J. J. Neidhart
B. C. Cooper	Floyd W. Sell
E. R. Domoney	J. G. L. Walden

Lighting in Kitchens, Lunchrooms, Cafeterias and Dining Areas

Carl Zersen, Chairman, Chicago Lighting Institute, 37 S. Wabash Ave., Chicago, Ill.

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A. P. Larson	M. W. Ross
C. T. Masterson	Lawrence A. Witt
Wm. Richards	Edward J. Wolff

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James P. Harding	Robert F. Quane
Paul P. Logan	C. L. Staples
Leo Lyons	R. W. Steenberg

Frank O. Washam

(Continued on page 24A)

New Corning Lightweight Curved Lens Panel

Fixture-length for More Pleasing Appearance

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City_____ Zone____ State_____

(*Continued from page* 22A)

Lighting in Theatres

R. T. Dorsey, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio

Jules Berinstein	James McCulloch
Eugene Braun	Edward Rambusch
Thomas W. Butler	Joel E. Rubin
J. R. Cravath	Ben Schlanger
C. M. Cutler	H. D. Sellman
T. Fuchs	George Smedberg
J. S. Hamel	Daniel Staehle.
G. D. Hanna	R. Gillespie Williams
H. A. Kliegl.	Frederick M. Wolff

LIGHT SOURCES — To correlate and report available information as to the physics of light and light production and the characteristics of current light sources.

E. H. Raddin, Chairman, Champion Lamp Works, Lynn, Mass.
George S. Evans, Vice-Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

L. E. Barbrow	A. C. Downes
Howard J. Berka	B. F. Greene
James Cox	E. F. Lowry
H. F. Davidson	A. B. Oday

E. H. Salter

LIGHTING MAINTENANCE — To study the elements contributing to maintenance factors; set up the framework of typical field studies to determine factors; and to stimulate the prosecution of such studies by appropriate agencies. Eric Church, Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

A. C. Barr	R. S. Rogge
A. A. Brainerd	R. P. Teele
E. F. Lowry	G. P. Wakefield
S. W. Quisenberry	Richard F. Townsend

MINE LIGHTING — To study the visibility levels in mining operations and to prepare lighting recommendations.

C. M. Crysler, Chairman, General Electric Co., 238 W. Carson St., Pittsburgh, Pa.

E. J. Coggershall	H. M. Horton
A. A. Eastman	W. H. Kahler
E. J. Gleim	J. E. LeBlanc
J. D. Hall	E. T. Querney
R. E. Havener	R. R. Richards

J. C. Smith

NOMENCLATURE — To define the terms and standards of illumination; and endeavor to obtain uniformity in nomenclature.

D. M. Finch, Chairman, University of California, Div. of Electrical Engineering, Berkeley, Calif.
J. O. Kraehenbuehl, Vice-Chairman, University of Illinois, 201 E. E. Annex, Urbana, Ill.

A. Abramowitz	L. A. Jones
E. Q. Adams	W. F. Little
Robert Bromberg	Warren W. Menke
C. L. Cottrell	Priscilla Presbrey
H. P. Gage	Harris Reinhardt
K. S. Gibson	C. C. Shotwell
S. K. Guth	H. P. Steele

OFFICE LIGHTING — To study the lighting requirements of office lighting tasks develop suitable lighting recommendations and report thereon.

J. J. Neidhart, Chairman, Westinghouse Electric Corp., 1216 W. 58th St., Cleveland 1, Ohio
G. F. Dean, Vice-Chairman, Toronto Hydro-Electric System, 14 Carlton St., Toronto, Ont.

A. S. Almryde	R. W. McKinley
C. T. Bakeman	R. L. Oetting
L. M. Endres	T. H. Shepherd
W. E. Folsom	George J. Taylor
G. C. Fowler	Roger T. Waite
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Hugh F. Carroll, Vice-Chairman, Pennsylvania Power &Light Co., 901 Hamilton St., Allentown, Pa.

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PROTECTIVE LIGHTING — To prepare standards for protective lighting of plants, yards, boundary fences, adjoining highways, railroad sidings, and waterway approaches for the purpose of reducing fire and theft risks, and making policing more effective.

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M. C. Harsh	G. G. Rae
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William Feuillan	Y. L. Ripley
E. W. Halteman	Kerr Sanders
W. F. Little	Orpha Mae Thomas

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SPORTS AND RECREATIONAL AREA LIGHTING — Develop current recommended practices for lighting sports and recreational areas; study techniques of application including effects on player performance and spectator visibility and report thereon.

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(*Continued on page* 26A)

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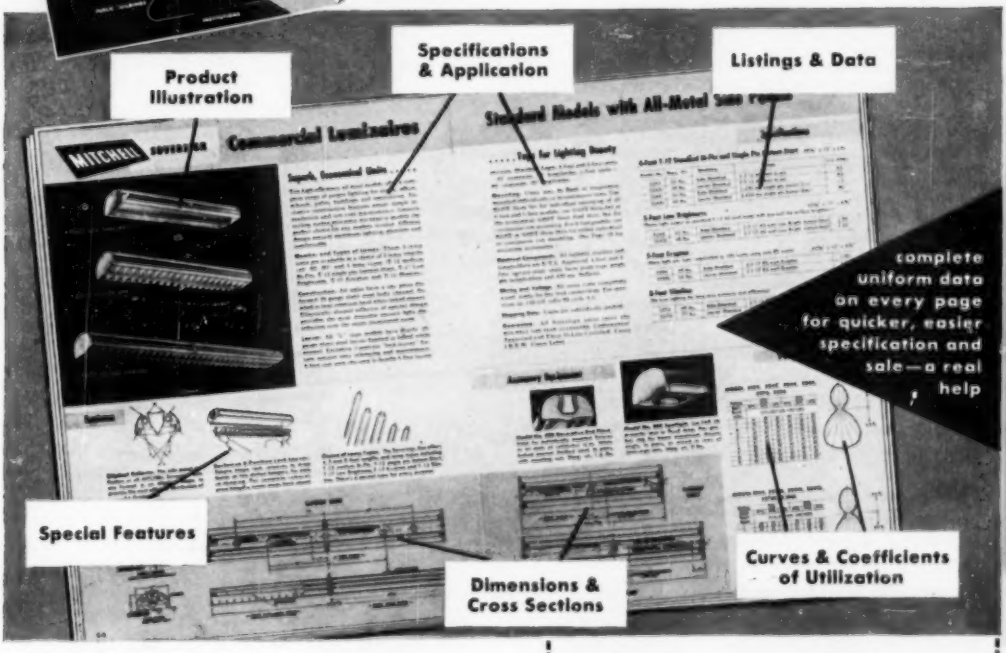
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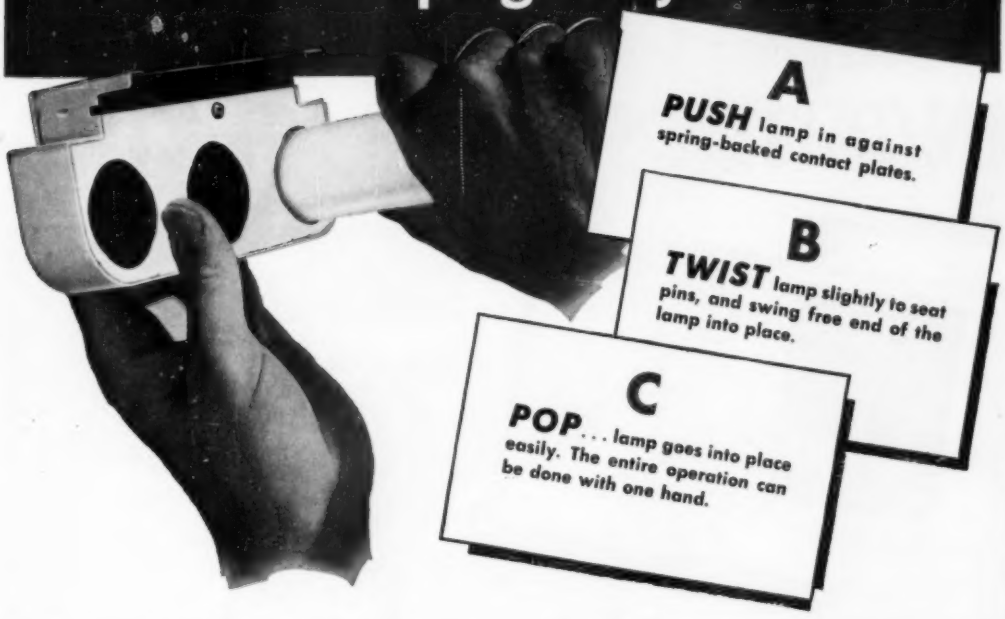
A
PUSH lamp in against spring-backed contact plates.
B
TWIST lamp slightly to seat pins, and swing free end of the lamp into place.
C
POP . . . lamp goes into place easily. The entire operation can be done with one hand.

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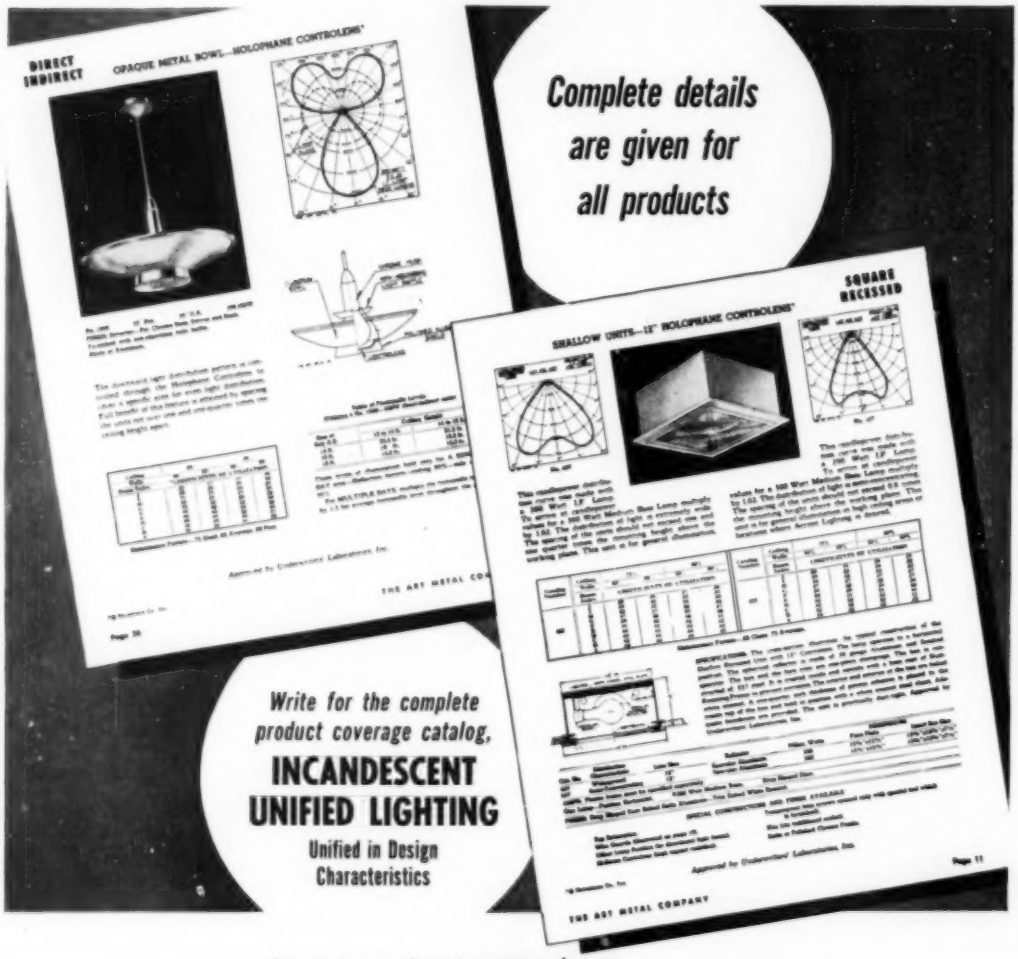

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minimum lamination hum:

The coils slip over the center leg which is then forced into the lamination stack SOLA's jig "pressed-in-core" assembly method produces a firm, solid core-and-coil assembly even before riveting, impregnating and compounding. This construction results in extremely quiet operation since lamination vibration is virtually eliminated.

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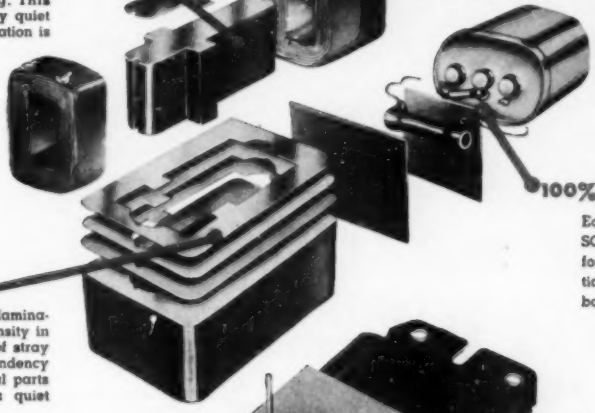

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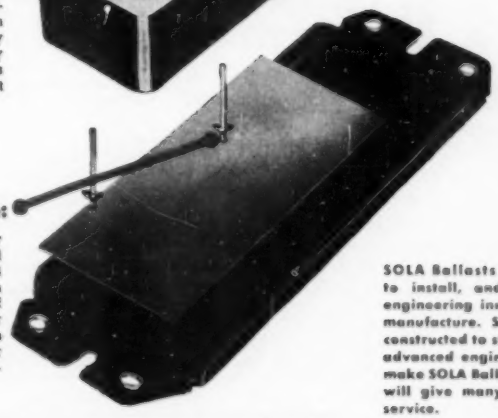

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(7) LIBRARY LIGHTING Recommended Practice (1950)

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(12) LIGHTING FOR FLOUR MILLS (1948)

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(13) LIGHTING FOR CANNERIES (1950)

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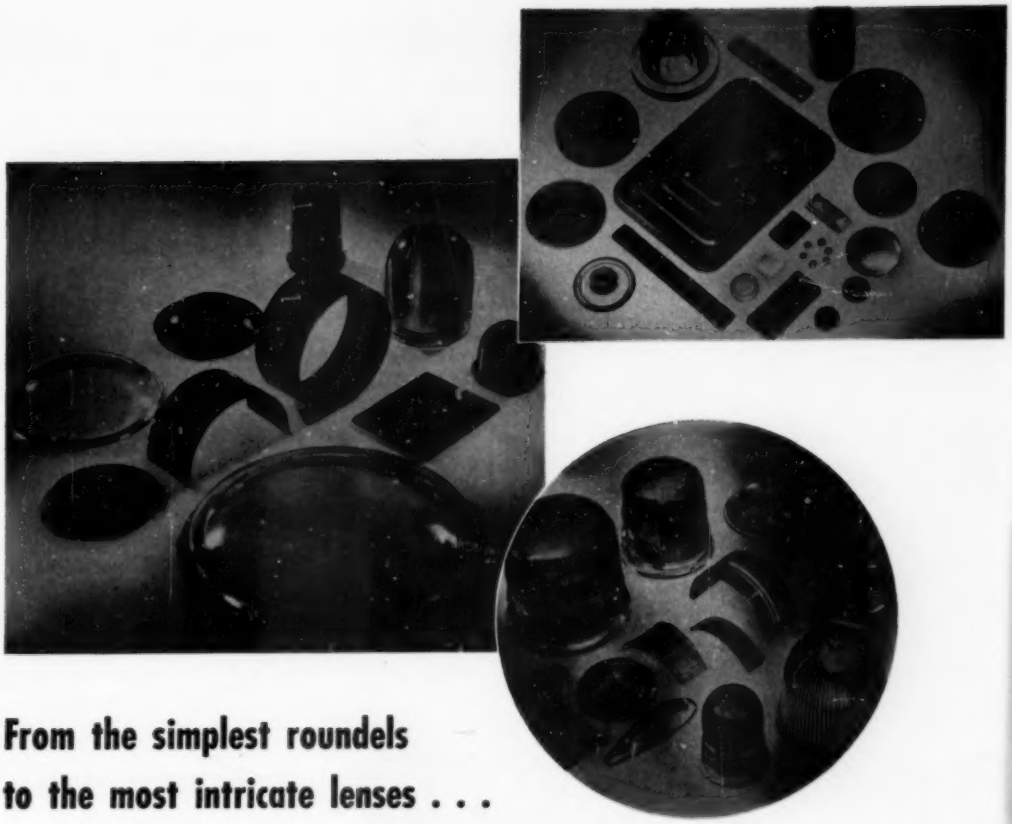

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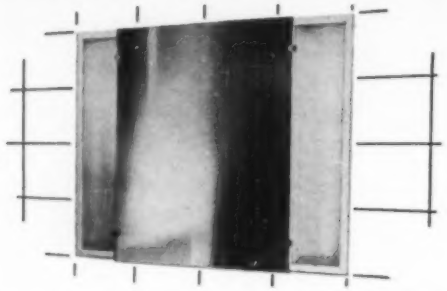

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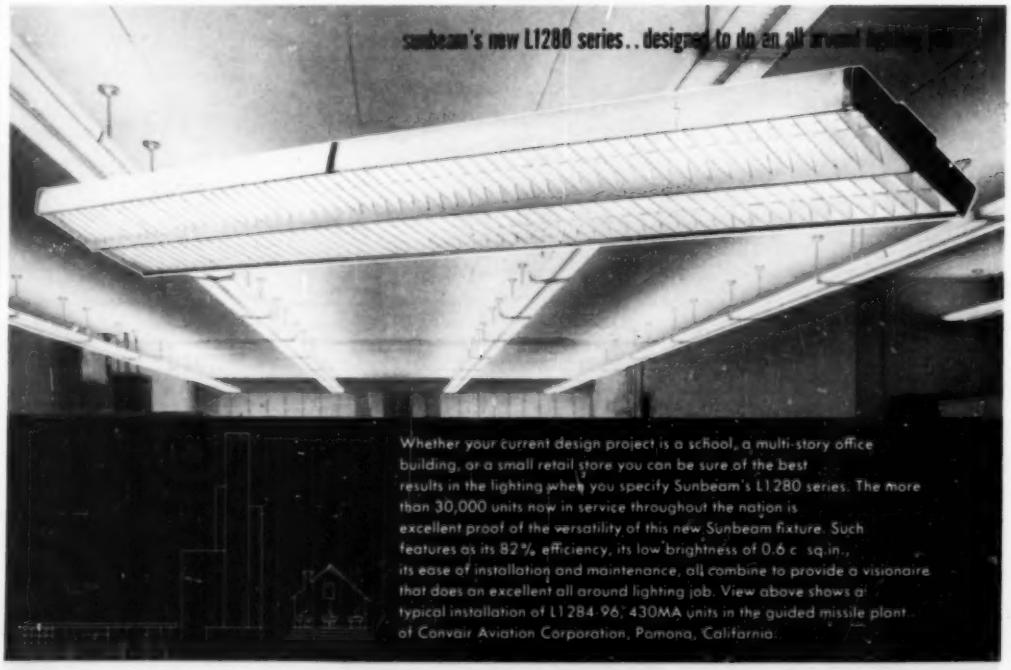

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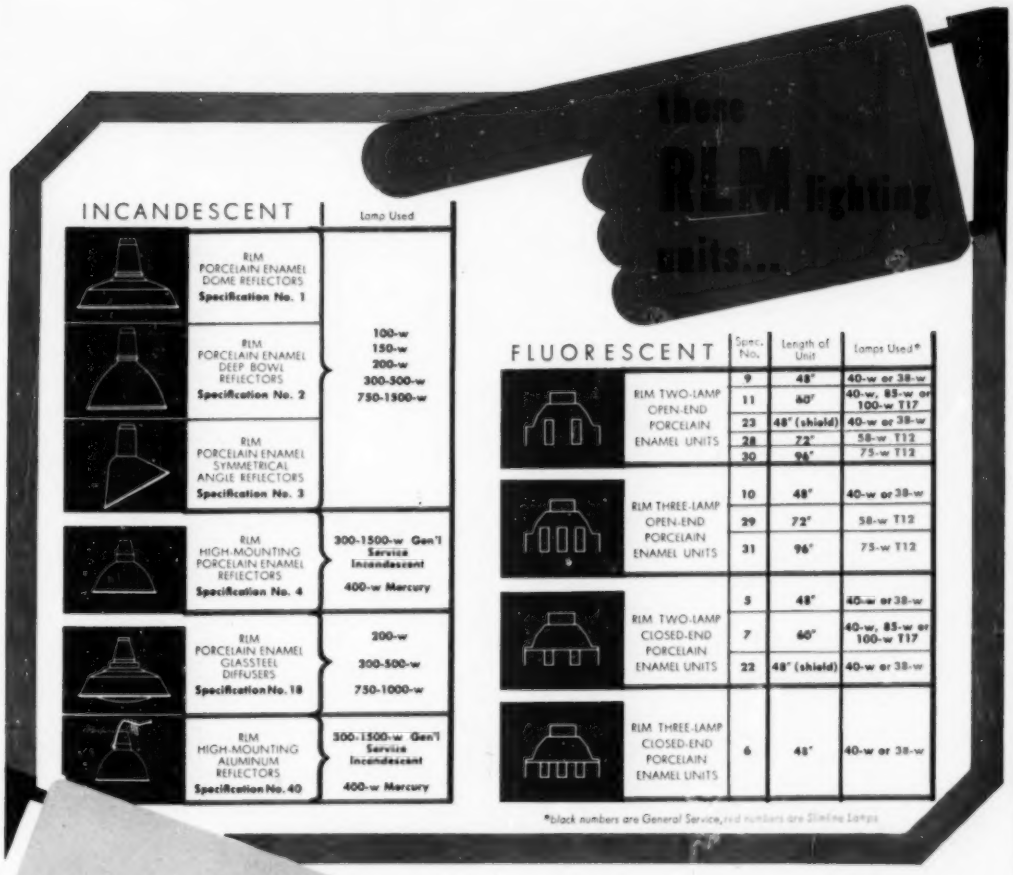
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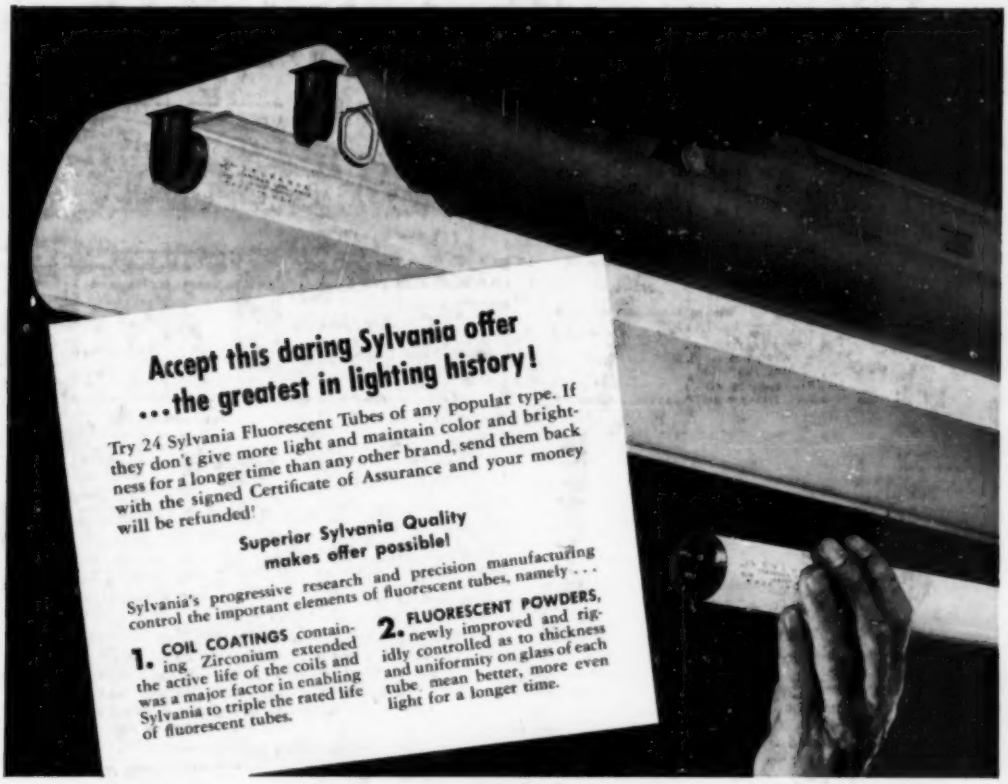

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